

# Operating Instructions

Diesel engine  
**20V 4000 C22**

**M015675/06E**



*Power. Passion. Partnership.*

Printed in Germany

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This handbook is provided for use by maintenance and operating personnel in order to avoid malfunctions or damage during operation.

Subject to alterations and amendments.

# Table of Contents

1	Safety		7.1.2	Engine - Barring with starting system	54
1.1	Important provisions for all products	5	7.2	Cylinder Liner	55
1.2	Personnel and organizational requirements	6	7.2.1	Endoscopically examining cylinder liner	55
1.3	Transport	7	7.2.2	Instructions and comments on endoscopic and visual examination of cylinder liners	57
1.4	Crankshaft transport locking device - For transport with flanged-on generator	8	7.3	Crankcase Breather	59
1.5	Safety regulations for startup and operation	10	7.3.1	Crankcase breather - Oil separator element replacement, diaphragm check and replacement	59
1.6	Safety regulations for maintenance and repair work	11	7.3.2	Crankcase breather - Cleaning	61
1.7	Fire prevention and environmental protection, consumable fluids and materials	14	7.3.3	Crankcase breather (open-circuit crankcase ventilation) - Filter element cleaning	62
1.8	Standards for safety notices in the text	16	7.3.4	Crankcase breather - Filter element replacement	63
2	General Information		7.4	Running Gear	65
2.1	Engine side and cylinder designations	17	7.4.1	Grounding device - Carbon brush check	65
2.2	Engine layout	18	7.4.2	Grounding device - Carbon brush replacement	67
2.3	Sensors and actuators - Overview	21	7.5	Valve Drive	68
3	Technical Data		7.5.1	Valve gear - Lubrication	68
3.1	20V 4000 C22 engine data	24	7.5.2	Valve clearance - Check and adjustment	69
3.2	Firing order	28	7.5.3	Cylinder head cover - Removal and installation	74
3.3	Main engine dimensions	29	7.6	Injection Pump / HP Pump	75
4	Operation		7.6.1	HP pump - Filling with engine oil	75
4.1	Putting the engine into operation after extended out-of-service periods (>3 months)	30	7.6.2	HP pump - Relief bore check	76
4.2	Putting the engine into operation after scheduled out-of-service-period	31	7.7	Injection Valve / Injector	77
4.3	Engine - Starting in manual mode	32	7.7.1	Injector - Replacement	77
4.4	Operational checks	33	7.7.2	Injector - Removal and installation	78
4.5	Engine - Stopping in manual mode	34	7.8	Fuel System	83
4.6	After shutting down the engine	35	7.8.1	Fuel system - Venting	83
4.7	Cleaning the plant	36	7.9	Fuel Filter	84
5	Maintenance		7.9.1	Fuel filter - Replacement	84
5.1	Maintenance Schedule task reference table [QL1]	37	7.9.2	Draining fuel prefilter	85
6	Troubleshooting		7.9.3	Edge-type fuel filter - Draining	86
6.1	Troubleshooting	38	7.9.4	Auxiliary fuel filter - Replacement	87
6.2	ECU 4 alarms	41	7.10	Charge-Air Cooling	88
7	Task Description		7.10.1	Intercooler - Check water drain for coolant leakage and absence of restrictions	88
7.1	Engine	52	7.11	Air Filter	89
7.1.1	Engine - Barring manually	52	7.11.1	Air filter element and dust bowl (optional) - Cleaning	89
			7.11.2	Air filter - Replacement	90
			7.11.3	Air filter element - Removal and installation (optional)	91
			7.11.4	Service indicator - Signal ring position check (optional)	92
			7.12	Starting Equipment	93
			7.12.1	Starter - Condition check	93

7.13	Lube Oil System, Lube Oil Circuit	94	7.18.1	Drive belt - Check condition	118
7.13.1	Checking engine oil level	94	7.19	Battery-Charging Generator	119
7.13.2	Engine oil - Change	95	7.19.1	Battery-charging generator - Removal	119
7.14	Oil Filtration / Cooling	96	7.19.2	Battery-charging generator - Check	120
7.14.1	Automatic oil filter - Oil filter candles replacement	96	7.19.3	Generator - Cleaning	121
7.14.2	Oil indicator filter - Cleaning and check	99	7.19.4	Battery-charging generator drive - Drive belt tension adjustment	122
7.14.3	Cleaning centrifugal oil filter and replacing filter sleeve	101	7.19.5	Battery-charging generator drive - Drive belt tension check	123
7.15	Coolant Circuit, General, High-Temperature Circuit	103	7.19.6	Battery-charging generator drive - Drive belt replacement	124
7.15.1	Engine coolant - Level check	103	7.20	Fan Drive	125
7.15.2	Engine coolant - Change	104	7.20.1	Fan drive - Drive belt tension check / adjustment	125
7.15.3	Engine coolant - Draining	105	7.20.2	Fan drive - Drive belt replacement	127
7.15.4	Engine coolant - Filling	106	7.21	Wiring (General) for Engine/Gearbox/Unit	128
7.15.5	Engine coolant pump - Checking pressure relief port	108	7.21.1	Engine wiring - Check	128
7.15.6	Engine coolant - Sample extraction and analysis	109	7.22	Accessories for (Electronic) Engine Governor / Control System	129
7.15.7	Engine coolant filter - Replacement	110	7.22.1	Engine governor and connectors - Cleaning	129
7.16	Low-Temperature Circuit	111	7.22.2	Checking engine control unit plug connections	130
7.16.1	Charge-air coolant - Level check	111	8	Appendix A	
7.16.2	Charge-air coolant - Change	112	8.1	Abbreviations	131
7.16.3	Charge-air coolant - Draining	113	8.2	MTU contact persons/service partners	134
7.16.4	Charge-air coolant system - Filling	114	9	Appendix B	
7.16.5	Charge-air coolant pump - Checking pressure relief port	116	9.1	Special Tools	135
7.17	Engine Mounting / Support	117	9.2	Index	143
7.17.1	Engine mounting - Check	117			
7.18	Belt Drive	118			



# 1 Safety

## 1.1 Important provisions for all products

### **Nameplate**

The product is identified by nameplate, model designation or serial number and must match with the information on the title page of this manual.

Nameplate, model designation or serial number can be found on the product.

### **General information**

This product may pose a risk of injury or damage in the following cases:

- Incorrect use
- Operation, maintenance and repair by unqualified personnel
- Modifications or conversions
- Noncompliance with the safety instructions and warning notices

### **Correct use**

The product is intended exclusively for the application specified in the contract or defined at the time of delivery.

This means that the equipment must be operated:

- Within the permissible operating parameters in accordance with the (→ product data)
- With fluids and lubricants approved by the manufacturer in accordance with the (→ Fluids and Lubricants Specifications of the manufacturer)
- With spare parts approved by the manufacturer in accordance with the (→ applicable Spare Parts Catalog)
- In the original as-delivered configuration or in a configuration approved by the manufacturer in writing (including engine control/parameters)
- In compliance with all safety instructions and in adherence to all warning notices in this manual
- In accordance with the maintenance requirements over the entire service life of the product (→ Maintenance Schedule)
- In compliance with the maintenance and repair instructions contained in this manual, in particular with regard to the specified tightening torques
- With the exclusive use of technical personnel trained in commissioning, operation, maintenance and repair
- By contracting only workshops authorized by the manufacturer to carry out repair and overhaul

Any other use is considered improper use and increases the risk of personnel injury or material damage in product operation. The manufacturer will accept no liability for such damage.

### **Modifications or conversions**

Unauthorized modifications to the product compromise safety.

The manufacturer will accept no liability or warranty claims for any damage caused by unauthorized modifications or conversions.

### **Spare parts**

Only genuine spare parts must be used to replace components or assemblies.

The manufacturer will accept no liability or warranty claims for any damage caused by the use of other spare parts.

## 1.2 Personnel and organizational requirements

### **Organizational measures of the operator**

This manual must be issued to all personnel involved in operation, maintenance, repair or transportation.

Keep this manual handy in the vicinity of the product such that it is accessible to operating, maintenance, repair and transport personnel at all times.

Use this manual as a basis for instructing personnel on product operation and repair, whereby the safety-relevant instructions, in particular, must be read and understood.

This is particularly important in the case of personnel who only occasionally perform work on or around the product. This personnel must be instructed repeatedly.

### **Personnel requirements**

All work on the product shall be carried out by trained and qualified personnel only.

- Training at the Training Center of the manufacturer
- Qualified personnel specialized in mechanical and plant engineering

The operator must define the responsibilities of the personnel involved in operation, maintenance, repair and transport.

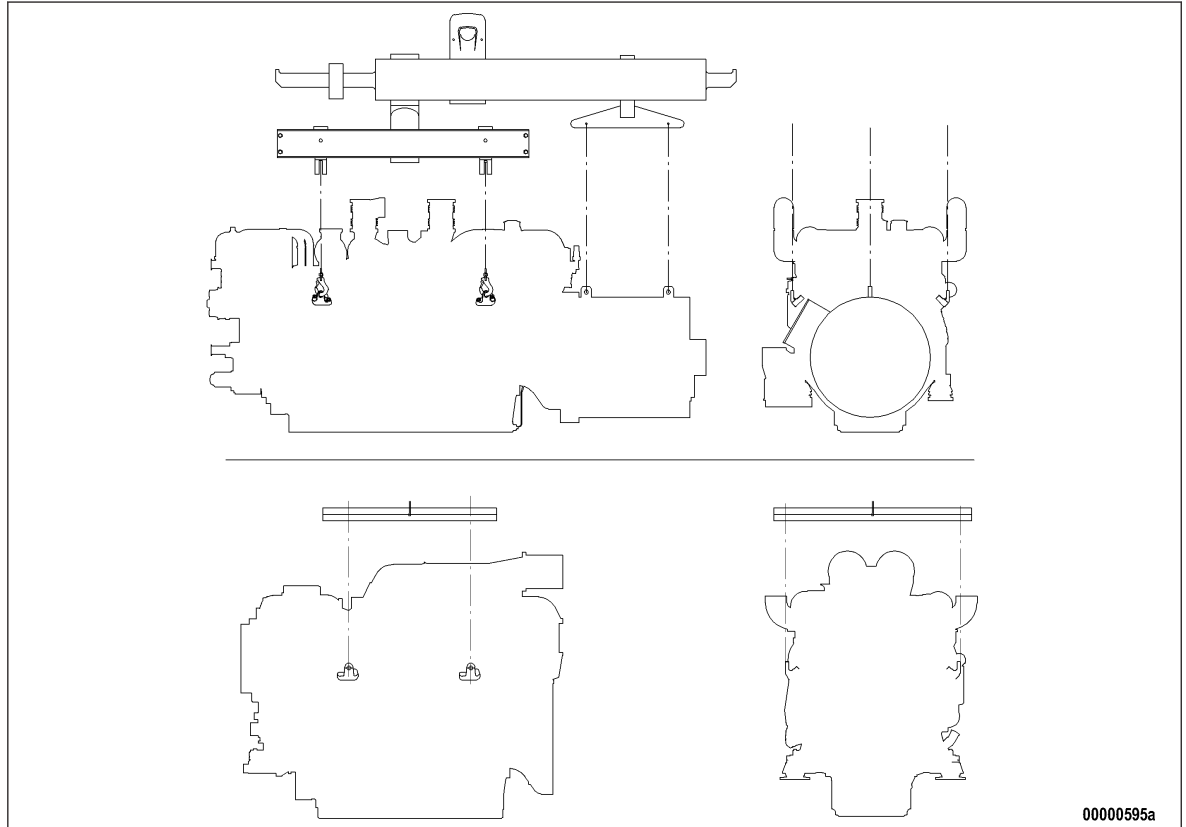
### **Working clothes and personal protective equipment**

Wear proper protective clothing for all work.

When working, always wear the necessary personal protective equipment (e.g. ear protectors, protective gloves, goggles, breathing protection). Observe the information on personal protective equipment in the respective activity description.

## 1.3 Transport

### Transport



Always use the lifting eyes on the engine and generator/gearbox when transporting gensets.

Always use the lifting eyes on the engine when transporting an engine separately.

Only use transport and lifting devices approved by MTU.

The engine/genset must only be transported in installation position: maximum permissible diagonal pull  $10^\circ$ .

Remove any loose parts on the genset.

Raise the engine/genset slowly. The lifting ropes or chains must not make contact with the engine or its components. Readjust lifting device as necessary.

Pay attention to the center of gravity of the engine/genset.

For special packaging with aluminium foil: Suspend the engine/genset by the lifting eyes on the bearing pedestal or transport by means of handling equipment (forklift truck) capable of bearing the load.

Fit the crankshaft transportation lock on the engine and fit the engine mount locking devices prior to transport.

Secure the engine/genset such as to preclude tipping during transport. Secure such as to preclude slipping and tipping when driving up or down inclines and ramps.

### Placement after transport

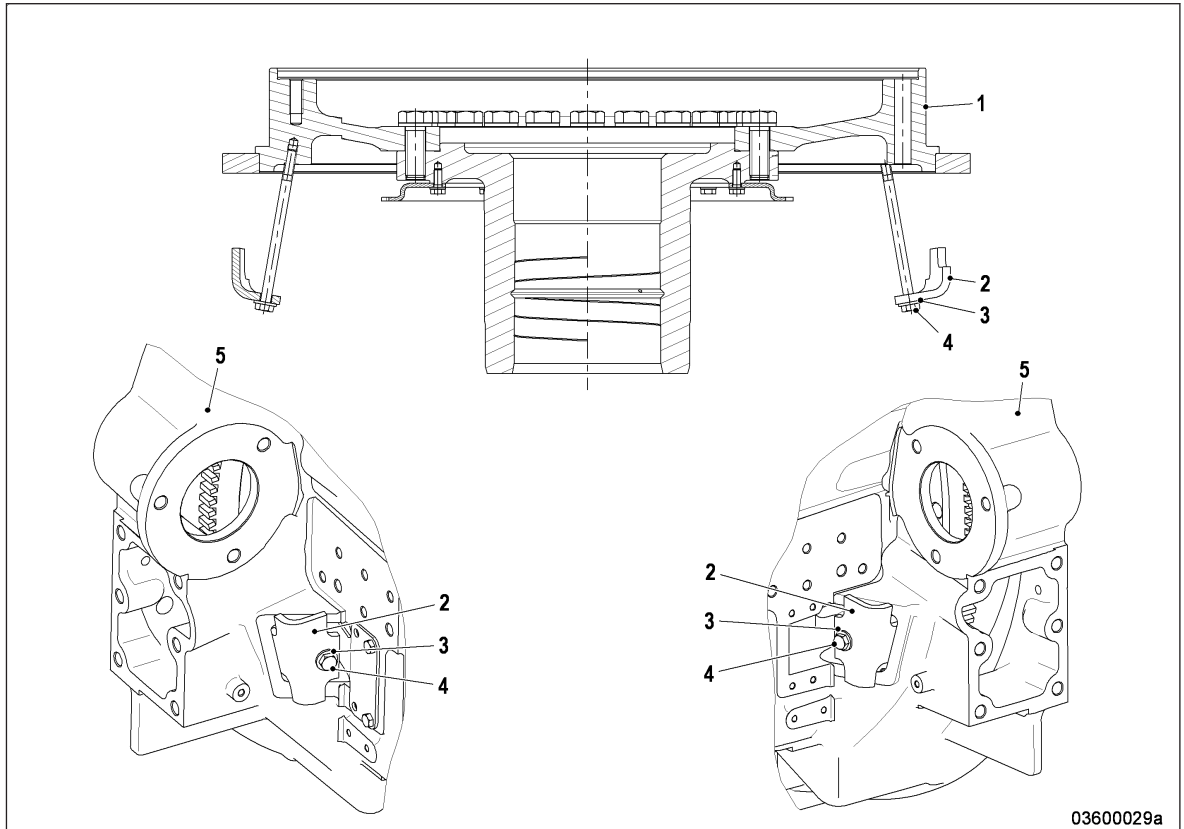
Place the engine/genset on a firm, flat surface only.

Make sure that the consistency and load-bearing capacity of the ground or support surface is adequate.

Never set an engine down on the oil pan unless expressly authorized to do so by MTU on a case-to-case basis.

## 1.4 Crankshaft transport locking device – For transport with flanged-on generator

### Transport



This locking device protects the crankshaft bearings from shocks and vibration damage during unit transport.

For removal of the transport locking device follow the following instructions:

- The transport locking device should remain installed as long as possible during unit installation in order to avoid damage.
- Starting or barring the engine is allowed only with the transport locking device removed. Make sure that the transport locking device of the generator is removed.
- Prior to every unit transport, this transport locking device must be reinstalled according to the instructions. The transport locking device of the generator is also to be fitted.

### Removing the transport locking device from driving end (KS)

- Remove screw (4) on both sides. Remove retainer (2) and washer (3).
- Remove guard plate from flywheel housing.

Store the removed parts of the transport locking device carefully for possible reuse!

### **Fitting the transport locking device on driving end (KS)**

- Remove protective cover from flywheel housing (5).  
Keep guard plate and screws on the engine. They must be reinstalled when the transport locking device has been removed.
- Turn crankshaft to bring cylinder A1 in TDC position.
- Check the threads on both sides of the flywheel (1) for ease of movement.
- Install retainer (2) with screw (4) and washer (3) through the opening in the flywheel housing (5) .  
Lubricant: engine oil.
- Tighten screw (4) in three steps. Tightening torque: 50 +5 Nm.
- Mark the engine as "Fitted with transportation locking device".

## 1.5 Safety regulations for startup and operation

### Safety regulations for startup

Install the product correctly and carry out acceptance in accordance the manufacturer's specifications before putting the product into service.

Before the product is put into operation for the first time, all official authorizations must be available and commissioning preconditions met.

When putting the product into operation, always ensure

- that all maintenance and repair work has been completed;
- that all loose parts have been removed from rotating machine components;
- that no-one is present in the danger zone of rotating machine components.

Immediately after putting the product into operation, make sure that all control and display instruments as well as the signaling and alarm systems work properly.

### Safety regulations for equipment operation

The operator must be familiar with the control and display elements.

The operator must be familiar with the consequences of any operations performed.

During operation, the display instruments and monitoring units must be permanently observed with regard to present operating status, violation of limit values and warning or alarm messages.

### Malfunctions and emergency stop

The procedures for cases of emergency, in particular, emergency stop, must be practiced regularly.

The following steps must be taken if a malfunction of the system is recognized or reported by the system:

- Inform supervisor(s) in charge,
- Analyze the message,
- If required, carry out emergency operations e.g. emergency stop.

### Operation

The following conditions must be fulfilled before starting the product:

- Wear ear protection.
- Ensure that the engine room is well ventilated.
- Do not inhale the exhaust gases of the product.
- Ensure that the exhaust system is free of leaks and that the gases are discharged to atmosphere.
- Mop up any leaked or spilt fluids and lubricants immediately or soak up with a suitable binding agent.
- Protect battery terminals, generator terminals or cables against accidental contact.

### Operation of electrical equipment

When electrical equipment is in operation, certain components of these appliances are electrically live.

Observe the safety instructions for these devices.

## 1.6 Safety regulations for maintenance and repair work

### **Safety regulations prior to maintenance and repair work**

Have maintenance or repair work carried out by qualified and authorized personnel only.

Allow the product to cool down to less than 50°C before starting maintenance work (risk of explosion of oil vapors, fluids and lubricants, risk of burning).

Before starting work, relieve pressure in systems and compressed-air lines which are to be opened. Use suitable containers of adequate capacity to catch fluids and lubricants.

When changing the oil or working on the fuel system, ensure that the engine room is adequately ventilated.

Never carry out maintenance and repair work with the product in operation.

Carry out function checks on a product in operation only if expressly permitted to do so.

Secure the product against unintentional starting, e.g. with start interlock.

Attach "Do not operate" sign in the operating area or to control equipment.

Disconnect the battery. Lock circuit breakers.

Close the main valve on the compressed-air system and vent the compressed-air line when pneumatic starters are fitted.

Disconnect the control equipment from the product.

The following additional instructions apply to starters with beryllium copper pinion:

- Breathing protection of filter class P2 must be applied during maintenance work to avoid health hazards caused by the beryllium-containing pinion. Do not blow out the interior of the flywheel housing or the starter with compressed air. Clean the flywheel housing inside with a class H dust extraction device as an additional measure.

### **Safety regulations during maintenance and repair work**

Take special care when removing ventilation or plug screws from the product. Cover the screw or plug with a rag to prevent fluids escaping under pressure.

Take care when draining hot fluids and lubricants (risk of burning).

Use only proper and calibrated tools. Observe the specified tightening torques during assembly or disassembly.

Carry out work only on assemblies or plants which are properly secured.

Never use lines for climbing.

Keep fuel injection lines and connections clean.

Always seal connections with caps or covers if a line is removed or opened.

Take care not to damage lines, in particular fuel lines, during maintenance and repair work.

Ensure that all retainers and dampers are installed correctly.

Ensure that all fuel injection and pressurized oil lines are installed with enough clearance to prevent contact with other components. Do not place fuel or oil lines near hot components.

Do not touch elastomeric seals if they have carbonized or resinous appearance unless hands are properly protected.

Note cooling time for components which are heated for installation or removal (risk of burning).

When working high on the equipment, always use suitable ladders and work platforms. Make sure components or assemblies are placed on stable surfaces.

Ensure particular cleanness during maintenance and repair work on the product. After completion of maintenance and repair work, make sure that no loose objects are in/on the product (e.g. cloths and cable ties)

## **Safety regulations after completion of maintenance and repair work**

Before barring, make sure that nobody is standing in the danger zone of the product.

Check that all guards have been reinstalled and that all tools and loose parts have been removed after working on the product (in particular, the barring tool).

## **Welding work**

Welding operations on the product or mounted units are not permitted. Cover the product when welding in its vicinity.

Before starting welding work:

- Switch off the power supply master switch.
- Disconnect the battery.
- Separate the electrical ground of electronic equipment from the ground of the unit.

No other maintenance or repair work must be carried out in the vicinity of the product while welding is going on. Risk of explosion or fire due to oil vapors and highly flammable fluids and lubricants.

Do not use product as ground terminal.

Never position the welding power supply cable adjacent to, or crossing wiring harnesses of the product. The welding current may otherwise induce an interference voltage in the wiring harnesses which could conceivably damage the electrical system.

Remove parts (e.g. exhaust pipes) which are to be welded from the product beforehand.

## **Hydraulic installation and removal**

Check the function and safe operating condition of tools and fixtures to be used. Use only the specified devices for hydraulic removal/installation procedures.

Observe the max. permissible push-on pressure specified for the equipment.

Do not attempt to bend or apply force to lines.

Before starting work, pay attention to the following:

- Vent the hydraulic installation/removal tool, the pumps and the lines at the relevant points for the equipment to be used (e.g. open vent plugs, pump until bubble-free air emerges, close vent plugs).
- For hydraulic installation, screw on the tool with the piston retracted.
- For hydraulic removal, screw on the tool with the piston extended.

For a hydraulic installation/removal tool with central expansion pressure supply, screw spindle into shaft end until correct sealing is established.

During hydraulic installation and removal, ensure that nobody is standing in the immediate vicinity of the component to be installed/removed.

## **Working with batteries**

Observe the safety instructions of the battery manufacturer when working with batteries.

Gases emanating from the battery are explosive. Avoid sparks and naked flames.

Do not allow electrolyte to come in contact with skin or clothing.

Wear protective clothing and protective gloves.

Never place tools on the battery.

Before connecting the cable to the battery, check the battery polarity. Battery pole reversal may lead to injury through the sudden discharge of acid or bursting of the battery body.



## **Working on electrical and electronic assemblies**

Always obtain the permission of the person in charge before commencing maintenance and repair work or switching off any part of the electronic system required to do so.

De-energize the appropriate areas prior to working on assemblies.

Do not damage cabling during removal work. When reinstalling ensure that wiring is not damaged during operation by contact with sharp objects, by rubbing against other components or by a hot surface.

Do not secure cables on lines carrying fluids.

Do not use cable binders to secure cables.

Always use connector pliers to tighten union nuts on connectors.

Subject the device as well as the product to a function check on completion of all repair work. In particular, check the function of the engine emergency stop feature.

Store spare parts properly prior to replacement, i.e. protect them against moisture in particular. Pack defective electronic components and assemblies in a suitable manner when dispatched for repair, i.e. protected, in particular, against moisture and impact and wrapped in antistatic foil if necessary.

## **Working with laser equipment**

When working with laser equipment, always wear special laser-protection goggles (hazard due to heavily focused radiation).

Laser equipment must be fitted with the protective devices necessary for safe operation according to type and application.

For conducting light-beam procedures and measurement work, only the following laser devices must be used:

- Laser devices of classes 1, 2 or 3A.
- Laser devices of class 3B, which have maximum output in the visible wavelength range (400 to 700 nm), a maximum output of 5 mW, and in which the beam axis and surface are designed to prevent any risk to the eyes.

## 1.7 Fire prevention and environmental protection, consumable fluids and materials

### Fire prevention

Rectify any fuel or oil leaks immediately. Oil or fuel on hot components can cause fires – therefore always keep the product in a clean condition. Do not leave cloths saturated with fluids and lubricants on the product. Do not store combustible materials near the product.

Do not carry out welding work on pipes and components carrying oil or fuel. Before welding, clean with a nonflammable fluid.

When starting the engine with an external power source, connect the ground lead last and remove it first. To avoid sparks in the vicinity of the battery, connect the ground lead from the external power source to the ground lead of the engine or to the ground terminal of the starter.

Always keep suitable firefighting equipment (fire extinguishers) at hand and familiarize yourself with their use.

### Noise

Noise can lead to an increased risk of accidents if it makes it more difficult to hear audible signals, warning calls or noises indicating danger.

Wear ear defenders in work areas with a sound pressure level in excess of 85dB (A).

### Environmental protection and disposal

Modification or removal of any mechanical/electronic components or the installation of additional components including the execution of calibration processes that might affect the emission characteristics of the product are prohibited by emission regulations. Emission control units/systems may only be maintained, exchanged or repaired if the components used for this purpose are approved by the manufacturer. Noncompliance with these guidelines will invalidate the design type approval issued by the emissions regulation authorities. The manufacturer does not accept any liability for violations of the emission regulations. The maintenance schedules of the manufacturer must be observed over the entire life cycle of the product.

Dispose of used consumables and filters in accordance with local regulations.

Within the EU, batteries can be returned free of charge to the manufacturer where they will be properly recycled.

### Consumable fluids and materials

The Fluids and Lubricants Specifications will be amended or supplemented as necessary. Prior to operation, make sure that the latest version is used. The latest version can be found on the website on the "Technical Info" tab at <http://www.mtu-online.com>.

Consumable fluids and materials may also be hazardous or toxic. When using fluids, lubricants, consumables and other chemical substances, follow the safety instructions that apply to the product. Take special care when using hot, chilled or caustic substances. When using flammable materials, prevent them coming into contact with ignition sources and do not smoke.

### Used oil

Used oil contains combustion residues that are harmful to health.

Rub barrier cream into hands.

Wash hands after contact with used oil.

## Lead

- Adopt suitable measures to avoid the formation of lead dust.
- Switch on extraction system.
- When working with lead or pastes that contain lead, avoid direct contact with the skin. Do not inhale lead vapors.
- Wash hands after contact with lead or lead-containing substances.

## Compressed air

Observe special safety precautions when working with compressed air:

- Unauthorized use of compressed air, e.g. forcing flammable liquids (hazard class A1, A2 and B) out of containers, risks causing an explosion.
- Wear goggles when blowing dirt off components or blowing away swarf.
- Blowing compressed air into thin-walled containers (e.g. containers made of sheet metal, plastic or glass) for drying purposes or to check for leaks risks bursting them.
- Pay special attention to the pressure in the compressed air system or pressure vessel.
- Assemblies or products to be connected must either be designed for that pressure, or, if the permissible pressure is lower than the system pressure, a pressure reducing valve and safety valve (set to the permissible pressure) must be connected between the assemblies/products and the system.
- Hose couplings and connections must be securely attached.
- Provide the snout of the air nozzle with a protective disk (e.g. rubber disk).
- First shut off compressed air lines before compressed air device is disconnected from the supply line, or before device or tool is to be replaced.
- Carry out leak test in accordance with the specifications.

## Paints and varnishes

- Observe the relevant safety data sheet for all materials.
- When painting in areas other than spray booths equipped with extractors, ensure good ventilation. Make sure that neighboring work areas are not adversely affected.
- There must be no naked flames in the vicinity.
- No smoking.
- Observe fire prevention regulations.
- Always wear a mask providing protection against paint and solvent vapors.





## Liquid nitrogen

- Observe the relevant safety data sheet for all materials.
- Store liquid nitrogen only in small quantities and always in regulation containers (without gas-tight caps).
- Avoid body contact (eyes, hands).
- Wear protective clothing, protective gloves, closed shoes and safety goggles.
- Make sure that working area is well ventilated.
- Avoid knocking or jolting the containers, fixtures or workpieces in any way.

## Acids/alkalis/urea solution (AdBlue, DEF)

- Observe the relevant safety data sheet for all materials.
- When working with acids and alkaline solutions, wear goggles or face mask, gloves and protective clothing.
- Do not inhale vapors.
- If urea solution is swallowed, rinse out mouth and drink plenty of water.
- If spilled onto clothing, remove the affected clothing immediately.
- After contact with skin, rinse affected parts of the body with plenty of water.
- Rinse eyes immediately with eyedrops or clean tap water. Seek medical attention as soon as possible.

## 1.8 Standards for safety notices in the text

<b>DANGER</b> 	In the event of immediate danger. <b>Consequences: Death, serious or permanent injury.</b> <ul style="list-style-type: none"><li>• Remedial action</li></ul>
<b>WARNING</b> 	In the event of a situation involving potential danger. <b>Consequences: Death, serious or permanent injury.</b> <ul style="list-style-type: none"><li>• Remedial action</li></ul>
<b>CAUTION</b> 	In the event of a situation involving potential danger. <b>Consequences: Minor or moderate injuries.</b> <ul style="list-style-type: none"><li>• Remedial action</li></ul>
<b>NOTICE</b> 	In the event of a situation involving potentially adverse effects on the product. <b>Consequences: Material damage.</b> <ul style="list-style-type: none"><li>• Remedial action</li><li>• Additional product information</li></ul>

### Safety notices

- This manual with all safety instructions and safety notices must be issued to all personnel involved in operation, maintenance, repair or transportation.

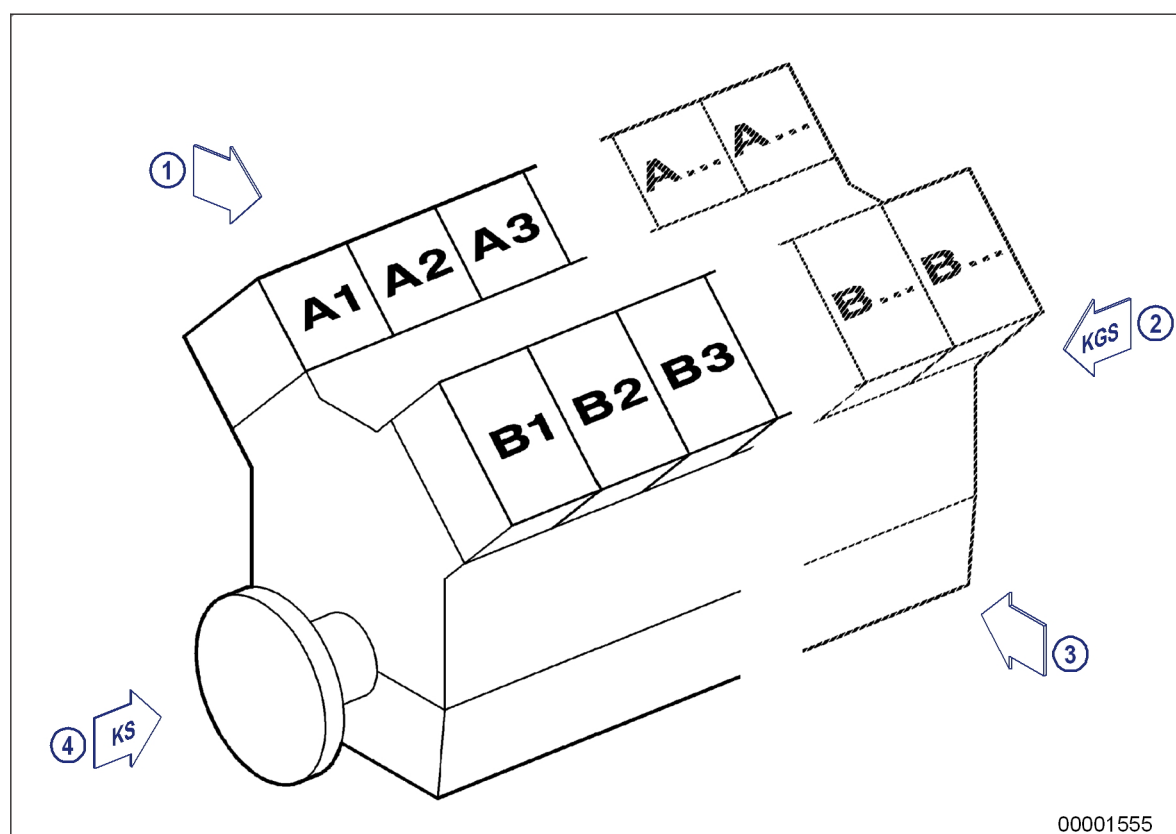
## 2 General Information

### 2.1 Engine side and cylinder designations

Engine sides are always designated as viewed from the driving end (KS) (4).

For designation of the cylinders (to DIN ISO 1204) the letter "A" (1) is used to refer to the cylinders on the left-hand side of the engine and the letter "B" (3) to refer to the cylinders on the right-hand side. The cylinders of each bank are numbered consecutively, starting with No. 1 at the driving end.

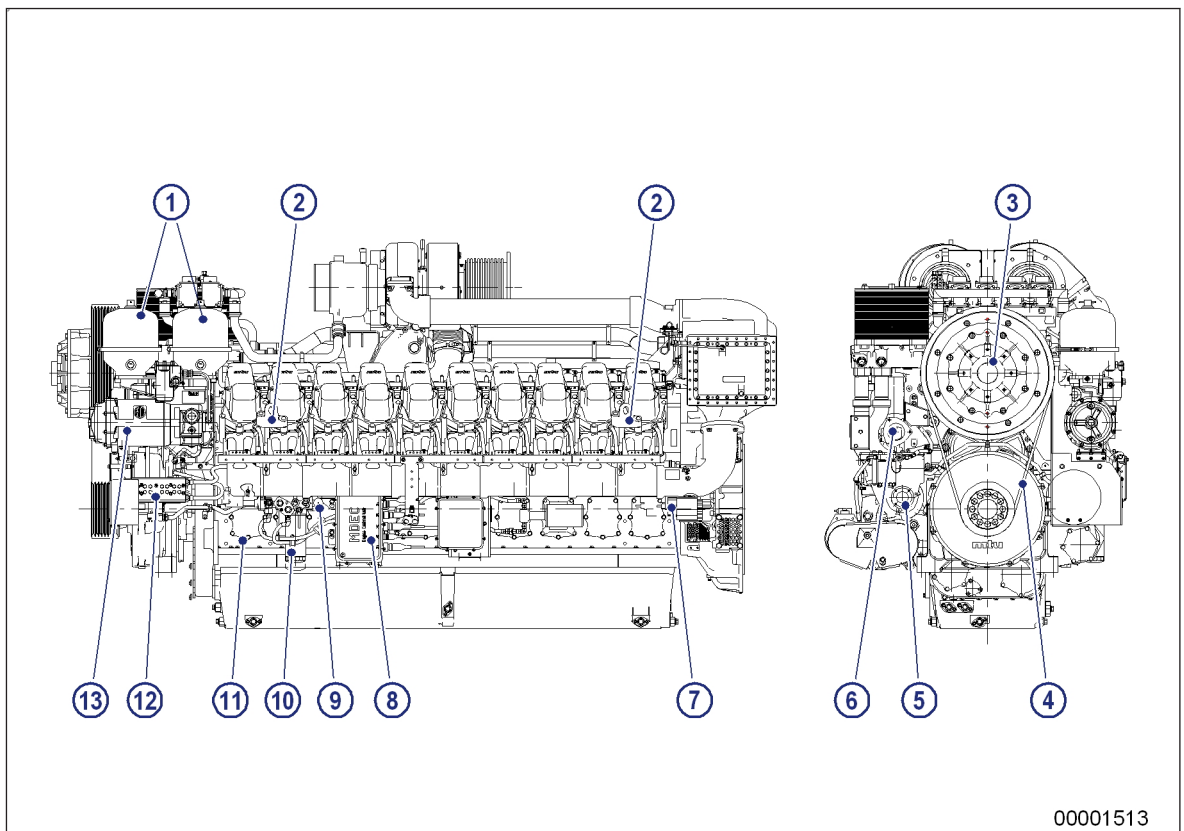
The numbering of other engine components also starts with no. 1 at the driving end.



1 Left-hand side of engine  
2 Auxiliary PTO end

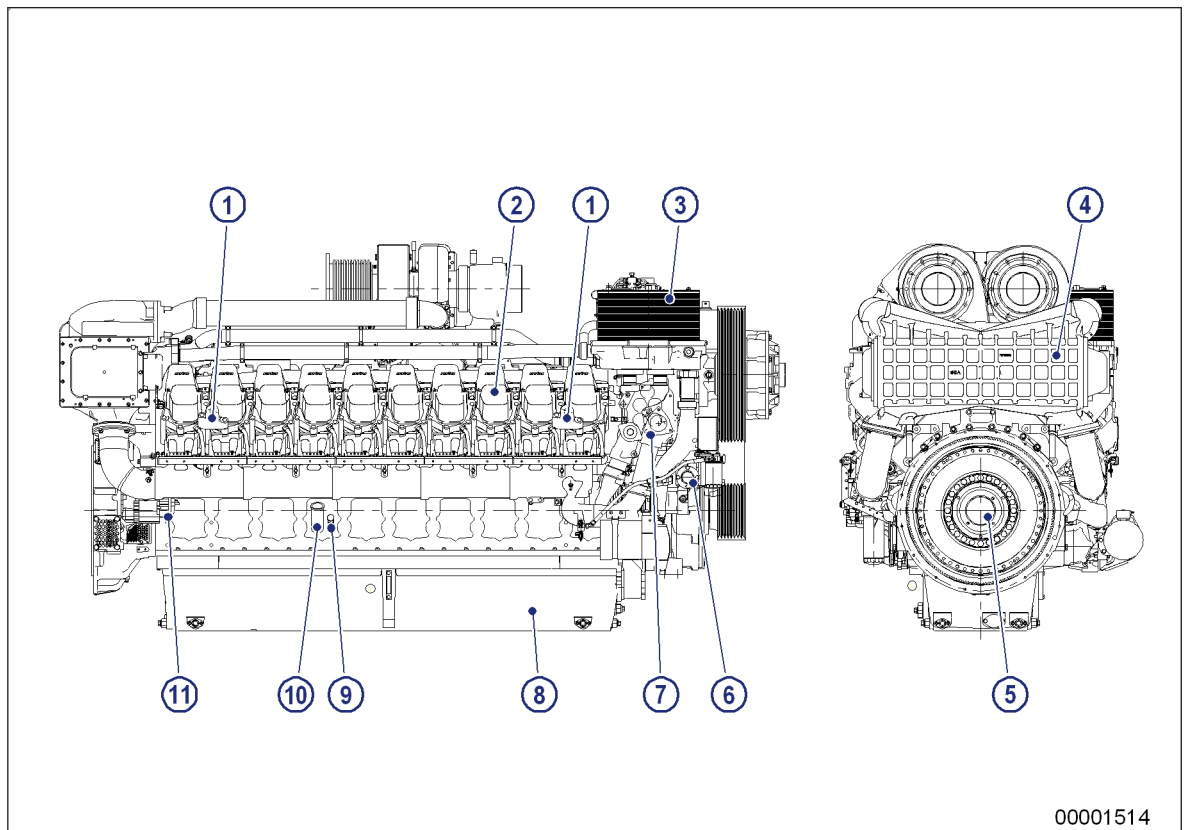
3 Right-hand side of engine  
4 Main PTO end

## 2.2 Engine layout



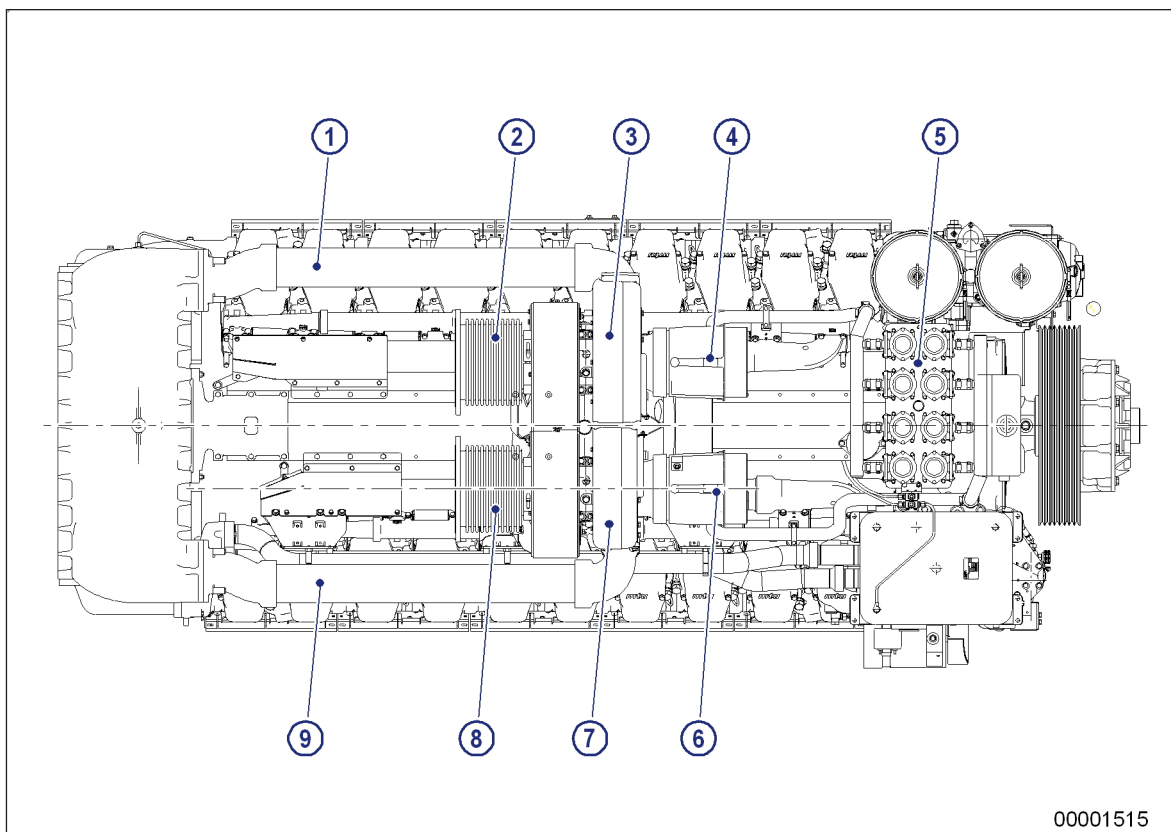
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- |                            |                                     |   |
|----------------------------|-------------------------------------|---|
| 1 Centrifugal oil filter   | 6 Engine coolant outlet             | 11 Crankcase                            |
| 2 Engine lifting eye       | 7 Starter (A side)                  | 12 HP fuel pump                         |
| 3 Fan drive                | 8 Engine Control Unit ECU 4         | 13 Engine oil filter (automatic filter) |
| 4 Drive belt               | 9 Fuel priming pump                 |   |
| 5 Charge-air coolant inlet | 10 Fuel filter (easy-change filter) |   |



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- |                                       |                             |                     |
|---------------------------------------|-----------------------------|---------------------|
| 1 Engine lifting eye                  | 5 Flywheel                  | 9 Oil dipstick      |
| 2 Cylinder head cover / cylinder head | 6 Charge-air coolant outlet | 10 Oil filler neck  |
| 3 Oil heat exchanger                  | 7 Engine coolant inlet      | 11 Starter (B side) |
| 4 Intercooler                         | 8 Oil pan                   |                     |



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- |   |                                 |  |
|---|---------------------------------|--|
| 1 Air supply downstream of intercooler (A side) | 4 Combustion air inlet (A side) | 7 Exhaust turbocharger (B side)          |
| 2 Exhaust system connection (A side)            | 5 Crankcase breather            | 8 Exhaust system connection (B side)     |
| 3 Exhaust turbocharger (A side)                 | 6 Combustion air inlet (B side) | 9 Air supply before intercooler (B side) |

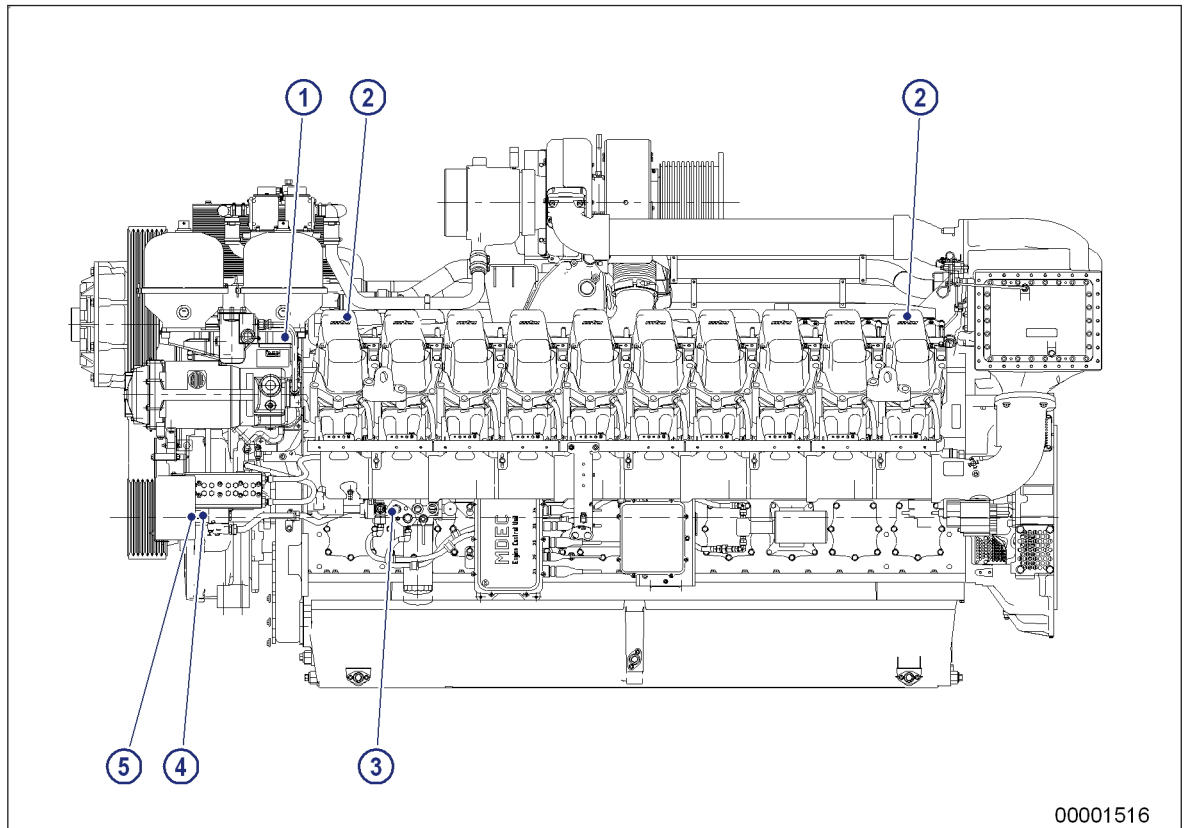
## Engine model designation

Key to the engine model designation 20V 4000 C22

20	Number of cylinders
V	Cylinder arrangement: V engine
4000	Series
C	Application: Construction and Industrial, mobile
2	Application segment
2	Design index



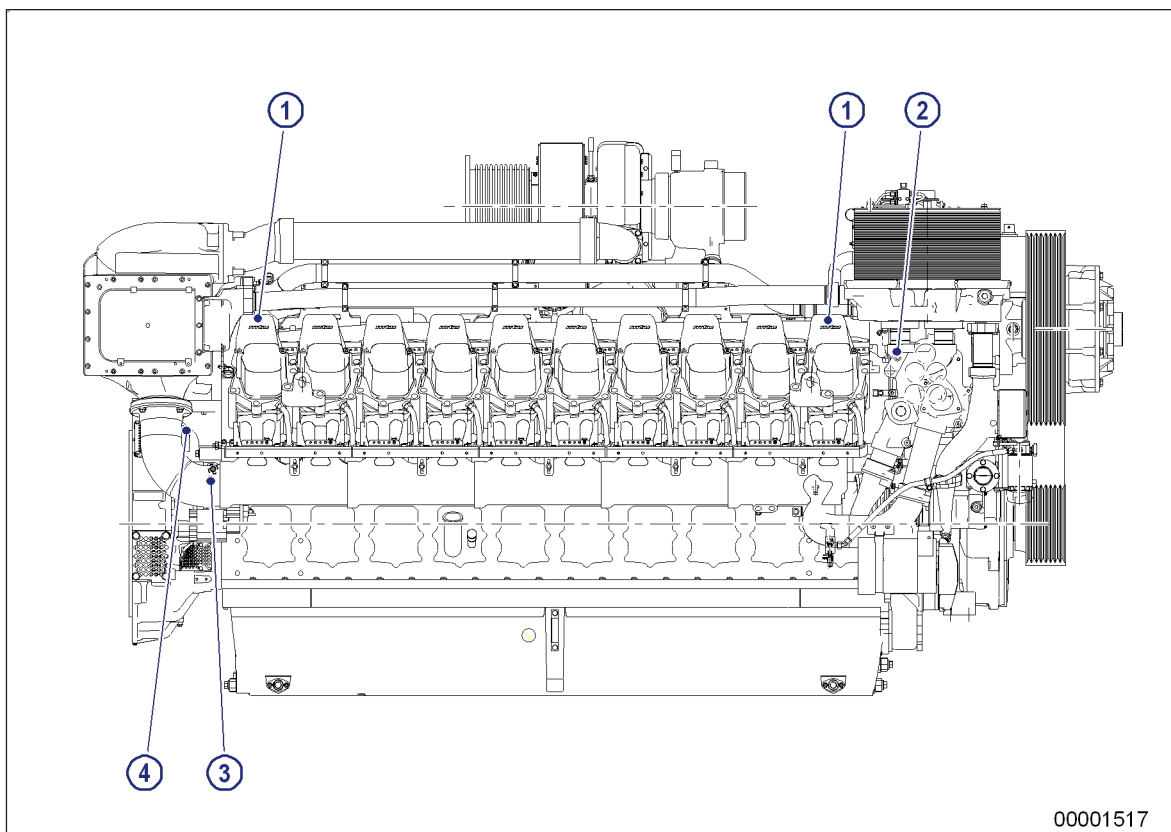
## 2.3 Sensors and actuators - Overview



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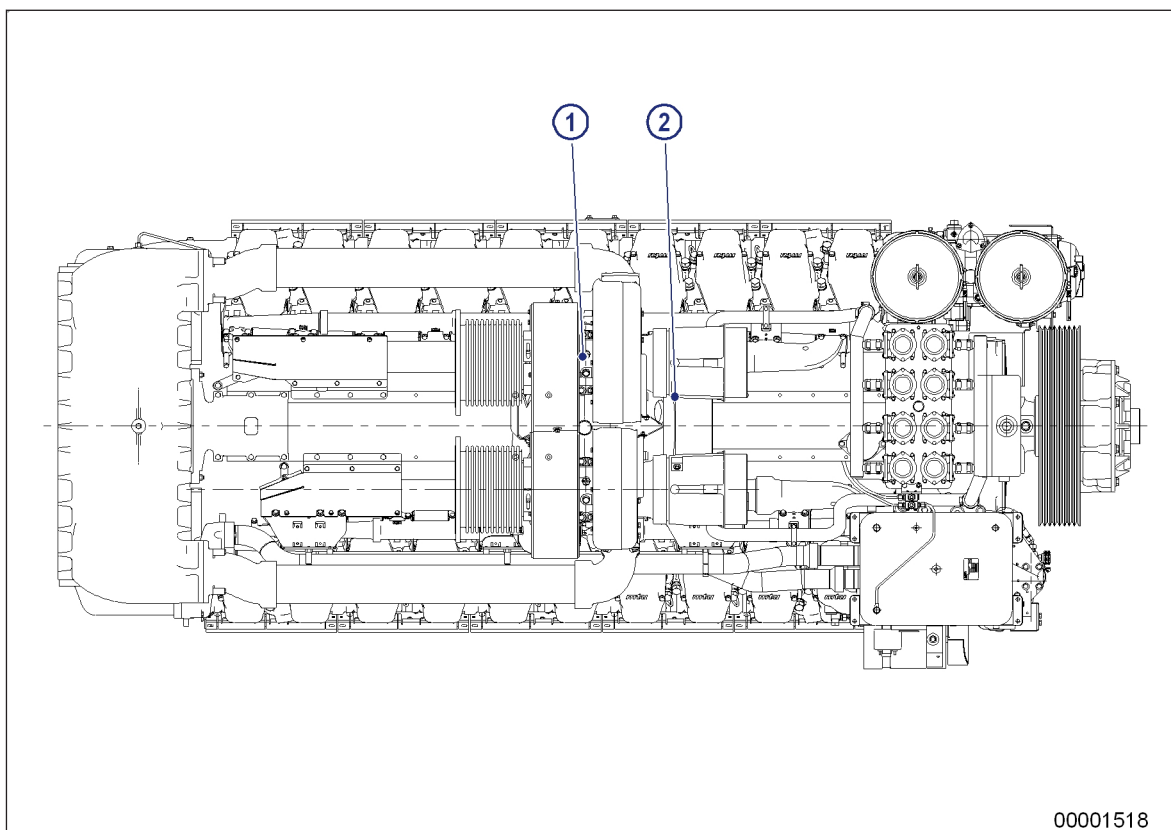
- |   |                             |                |
|---|-----------------------------|----------------|
| 1 B07 (T-Lube oil)                                | 3 B34 (P-Fuel after filter) | 5 B33 (T-Fuel) |
| 2 Injectors Y39.1 to Y39.10<br>(A side cylinders) | 4 B48 (P-Fuel)              |                |

The injectors are underneath the cylinder head covers of the cylinder. Injector replacement and necessary activities (→ Page 77).



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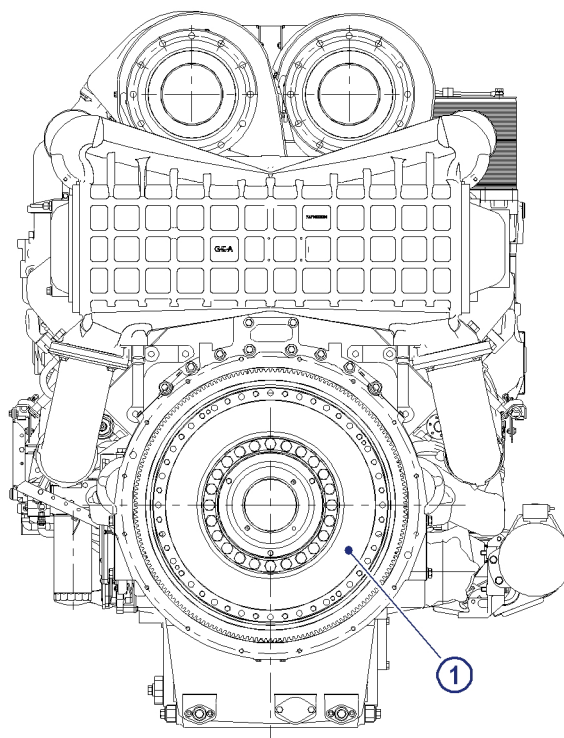
- |                           |                      |
|---------------------------|----------------------|
| 1 Injectors Y39.11 to     | 3 B10 (P-Charge Air) |
| Y39.20 (B side cylinders) | 4 B09 (T-Charge Air) |
| 2 B16 (P-Coolant)         |                      |



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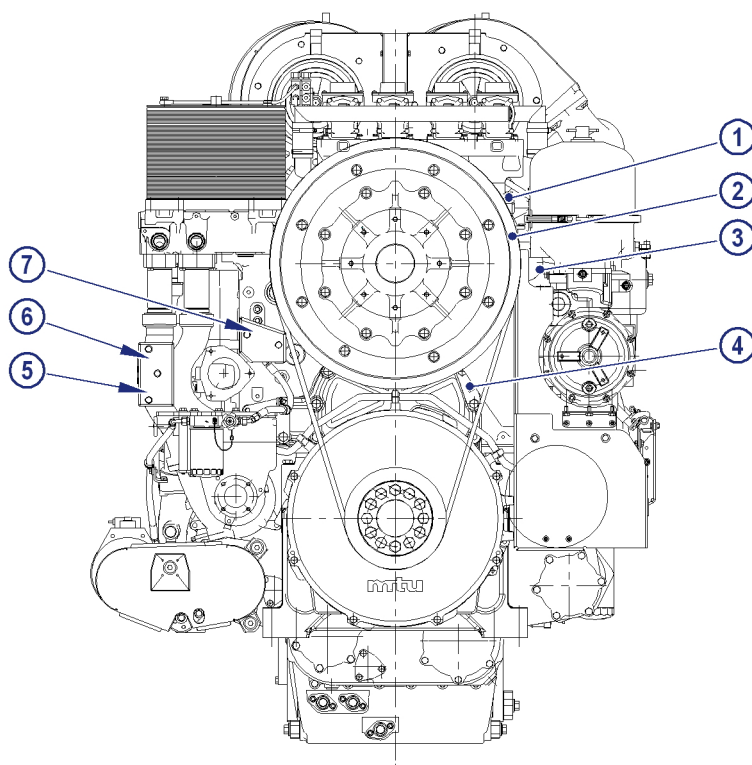
- |                        |                      |
|------------------------|----------------------|
| 1 B44 (N-Turbocharger) | 2 B03 (T-Intake Air) |
|------------------------|----------------------|

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1 B13 (N-Crankshaft)



00001520

- |                                      |                               |                   |
|--------------------------------------|-------------------------------|-------------------|
| 1 B50 (P-Crankcase)                  | 4 B01 (N-Camshaft)            | 7 B06 (T-Coolant) |
| 2 F25 (P-Lube Oil Diff.after Filter) | 5 B43 (P-Coolant Intercooler) |                   |
| 3 B05 (P-Lube Oil)                   | 6 B26 (T-Coolant Intercooler) |                   |

## 3 Technical Data

### 3.1 20V 4000 C22 engine data

Explanation:

- DL Ref. value: Continuous power (CP)
- BL Ref. value: Fuel stop power (FSP)
- A Design value
- G Guaranteed value
- R Guideline value
- L Limit value, up to which the engine can be operated, without change (e.g. of power setting)
- N Not yet defined value
- Not applicable
- X Applicable

#### Reference Conditions

Engine model			20V 4000
Application group			5B
Intake air temperature		°C	25
Charge-air coolant temperature		°C	45
Barometric pressure		mbar	1000
Site altitude above sea level		m	100

#### POWER-RELATED DATA (power ratings are net brake power to ISO 3046)

Number of cylinders			20V 4000
Engine rated speed	A	rpm	1800
Net brake power (without fan) (fuel stop power ISO 3046)	A	kW	2720

#### GENERAL CONDITIONS (for maximum power)

Number of cylinders			20V 4000
Intake air depression (new filter)	A	mbar	25
Intake air depression	L	mbar	50
Exhaust backpressure	A	mbar	30
Exhaust backpressure, max.	L	mbar	50
Fuel temperature at engine supply connection	R	°C	25

#### CONSUMPTION

Number of cylinders			20V 4000
Specific fuel consumption (be) 100% BL (+5%; EN 590; 42.8MJ/kg)	G	g/kWh	200
Lube oil consumption after 100 h operation, average (B = fuel consumption per hour)	R	% of B	0.3

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## MODEL-RELATED DATA (basic design)

Number of cylinders			20V 4000
Number of cylinders			20
Cylinder configuration: V angle		degrees	90
Bore		mm	165
Stroke		mm	210
Cylinder displacement		liter	4.49
Total displacement		liter	89.81
Number of inlet valves, per cylinder			2
Number of exhaust valves, per cylinder			2

## COMBUSTION AIR / EXHAUST GAS

Number of cylinders			20V 4000
Charge-air pressure before cylinder	R	bar abs	3.4
Exhaust temperature after turbocharger	R	°C	420

## COOLING SYSTEM (HT circuit)

Number of cylinders			20V 4000
Coolant temperature (at engine outlet to cooling equipment)	A	°C	95
Coolant temperature after engine, alarm	R	°C	97
Coolant temperature after engine, shutdown	L	°C	99
Coolant antifreeze content, max. permissible	L	%	50
Coolant pump: inlet pressure, min.	L	bar	0.2
Coolant pump: inlet pressure, max.	L	bar	1.5
Thermostat: starts to open	R	°C	79
Thermostat: fully open	R	°C	92

## COOLING SYSTEM (LT circuit)

Number of cylinders			20V 4000
Coolant temperature (at engine outlet to cooling equipment)	R	°C	68
Coolant temperature before intercooler (with max. 40% antifreeze)	A	°C	45
Coolant temperature differential after/before intercooler, max.	L	°C	18
Coolant antifreeze content, max. permissible	L	%	50
Charge-air temperature after intercooler, max. admissible	L	°C	72
Thermostat: starts to open	R	°C	38
Thermostat: fully open	R	°C	51

## LUBE OIL SYSTEM

Number of cylinders			20V 4000
Lube oil operating temperature before engine, from	R	°C	86
Lube oil operating temp. before engine, to	R	°C	95
Lube oil operating pressure before engine (measuring block)	R	bar	5.3

Number of cylinders			20V 4000
Lube oil pressure before engine, alarm	R	bar	4.5
Lube oil pressure before engine, shutdown	L	bar	3.9

## FUEL SYSTEM

Number of cylinders			20V 4000
Fuel pressure at supply connection to engine (when engine is starting), min. admissible	L	bar	- 0.1
Fuel pressure at supply connection to engine (when engine is starting), max. admissible	L	bar	1.5
Fuel pressure before injection pump, from (H.P. pump)	R	bar	5.0
Fuel pressure before injection pump, to (H.P. pump)	R	bar	8.1
Fuel pressure before injection pump, min (H.P. pump)	R	bar	5.0

## GENERAL OPERATING DATA

Number of cylinders			20V 4000
Coolant temperature before full-load operation, recommended min. (for standby plants with coolant preheating at least preheating temperature)	R	°C	60

## INCLINATIONS STANDARD OIL SYSTEM (Ref.: waterline)

Number of cylinders			20V 4000
Longitudinal inclination, continuous max., driving end down (Option: max. operating inclinations)	L	degrees	10
Longitudinal inclination, continuous max., driving end up (Option: max. operating inclinations)	L	degrees	10
Longitudinal inclination, temporary max., driving end up (Option: max. operating inclinations)	L	degrees	22.5

## CAPACITIES

Number of cylinders			20V 4000
Engine coolant capacity (without cooling equipment)	R	liter	205
Engine oil capacity, initial filling (standard oil system) (Option: max. operating inclinations)	R	liter	390
Oil pan capacity, dipstick mark min. (standard oil system) (Option: max. operating inclinations)	L	liter	340
Oil pan capacity, dipstick mark max. (standard oil system) (Option: max. operating inclinations)	L	liter	245

## WEIGHTS / MAIN DIMENSIONS

Number of cylinders			20V 4000
Engine weight, dry (basic engine configuration)	R	kg	9865

## ACOUSTICS

Number of cylinders			16
Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	118
Engine surface noise with attenuated, BL, intake noise (filter) (free-field sound-pressure level Lp, 1m distance, ISO 6798)	R	db(A)	108

## 3.2 Firing order

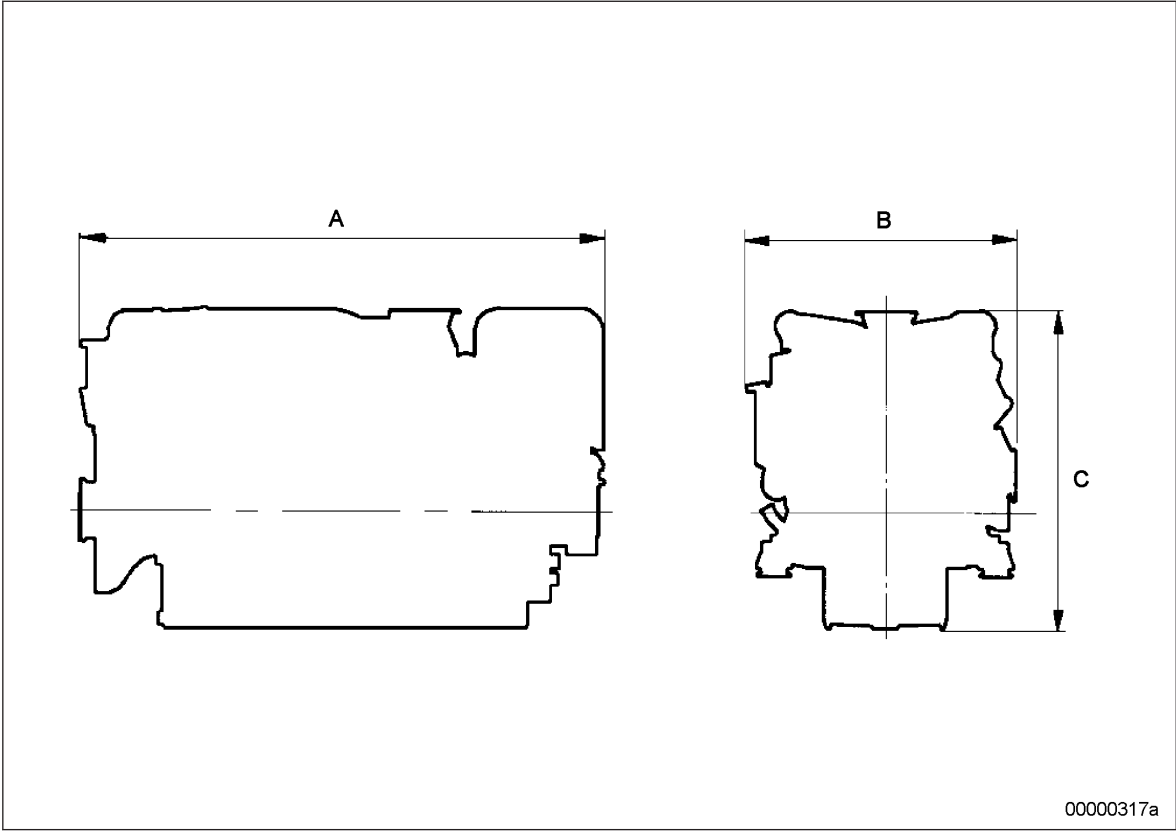
### Firing order

Number of cylinders	Firing order
8V	A1-B4-A4-A2-B3-A3-B2-B1
12V	A1-B2-A5-B4-A3-B1-A6-B5-A2-B3-A4-B6
16 V	A1-A7-B4-B6-A4-B8-A2-A8-B3-B5-A3-A5-B2-A6-B1-B7
20 V	A1-B5-A8-B7-A5-B2-A7-B10-A2-B3-A10-B6-A3-B4-A6-B9-A4-B1-A9-B8



### 3.3 Main engine dimensions

#### Main engine dimensions



Length (A)	approx. 3630 mm
Width (B)	approx. 1450 mm
Height (C)	approx. 2252 mm

## 4 Operation

### 4.1 Putting the engine into operation after extended out-of-service periods (>3 months)

#### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

#### Putting into operation after long out-of-service periods (>3 months)

Item	Action
Engine	Depreserve (→ MTU Fluids and Lubricants Specifications A001061/..).
Valve gear	Lubricate valve gear (→ Page 68).
Lube oil system	Check engine oil level (→ Page 94).
Fuel system	Vent (→ Page 83).
Coolant circuit	If engine is out of service for more than one year, change engine coolant (→ Page 104). Change charge-air coolant (→ Page 112).
Coolant circuit	Check engine coolant level (→ Page 103). Check charge-air coolant level (→ Page 111).
Coolant circuit	Preheat coolant with coolant preheating unit (if provided).
Engine governor	Check plug-in connections (→ Page 130).
Engine control system ECS	Switch ON.

## 4.2 Putting the engine into operation after scheduled out-of-service-period

### Preconditions

☑ Engine is stopped and starting disabled.



### Startup

Item	Action
Lube oil system	Check engine oil level (→ Page 94).
Coolant circuit	Check engine coolant level (→ Page 103); Check charge-air coolant level (→ Page 111).
Coolant circuit	Preheat coolant with coolant preheating unit (if applicable).
Engine control system	Put into operation.

## 4.3 Engine – Starting in manual mode

### Preconditions

- ☒ Engine is not under load.
- ☒ External start interlock is not activated.

<b>DANGER</b> 	Rotating and moving engine parts. <b>Risk of crushing, danger of parts of the body being caught or pulled in.</b> <ul style="list-style-type: none"><li>Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.</li></ul>
<b>WARNING</b> 	A high level of noise is produced when the engine is running. <b>Risk of damage to hearing.</b> <ul style="list-style-type: none"><li>Wear ear defenders.</li></ul>

### Preparation

Item	Measure
Operating mode switch (if applicable).	Switch to manual mode.
Coolant preheating unit (if applicable).	Switch ON

### Start engine

Item	Measure
Switchgear cabinet, operator station etc. (depending on manufacturer).	<ol style="list-style-type: none"><li>If no coolant preheater is fitted, make sure that the coolant temperature is <math>&gt; 40\text{ }^{\circ}\text{C}</math>.</li><li>Press start button.<ul style="list-style-type: none"><li>Automatic starting procedure is performed.</li><li>Engine speed instrument indicates increasing speed.</li><li>After the starting sequence is completed, engine is running at idle speed.</li></ul></li></ol>

## 4.4 Operational checks

### DANGER



Unguarded rotating and moving engine components.

**Risk of serious injury – danger to life!**

- Take special care when working on a running engine.

### WARNING



Engine noise above 85 dB (A).

**Risk of damage to hearing!**

- Wear ear protectors.

### Operational checks

Item	Task	Task Code
Control and display panels	Check indicated operating parameters (speed, temperatures, pressures).	
Engine oil	Check engine oil level (→ Page 94).	W0500
Engine operation	Check engine visually for leaks and general condition; Check engine for abnormal running noises, exhaust color and vibrations (→ Page 38).	W0501 W0506
Battery-charging generator	Check battery-charging generator for contamination, clean as required (→ Page 120)	W0525
HP pump	Check relief bore (→ Page 76).	W0504
Fuel prefilter	Drain water and contaminants at drain cock on fuel prefilter (if fitted) (→ Page 86). Check reading on vacuum gauge of fuel prefilter (if fitted).	W0507 W0508
Intercooler	Check condensate drain(s) for water discharge and obstruction (→ Page 88).	W0502
HT cooling pump	Check relief bore (→ Page 108).	W0505
LT cooling pump	Check relief bore (→ Page 116).	W0505

## 4.5 Engine – Stopping in manual mode

### Preconditions

- ☑ Engine is not under load.
- ☑ Engine is running in manual mode.

#### NOTICE



Stopping the engine when it is running at full load subjects it to extreme thermal and mechanical stresses.

**Overheating of and, therefore, damage to components is possible.**

- Before shutting down the engine, allow it to idle until the engine temperatures decrease and constant levels are indicated.

### Preparation

Item	Measure
Engine	Operate engine at idling speed for approx. 5 minutes.

### Stop engine

Item	Measure
Switch cabinet, operator station etc. (depending on manufacturer)	Press stop button. <ul style="list-style-type: none"><li>• Automatic stopping sequence is executed.</li></ul>

## 4.6 After shutting down the engine

### Preconditions

☑ MTU Corrosion-proofing and Reproofing Regulations (A001070/..) are available.

### After shutting down the engine

Item	Action
Coolant system	Drain coolant (→ Page 105), (→ Page 113), if: <ul style="list-style-type: none"><li>• freezing temperatures are expected and the engine is to remain out of service for an extended period, but engine coolant has no antifreeze additive;</li><li>• coolant is not preheated;</li><li>• antifreeze concentration is 50 % and outside temperature is below -40 °C.</li></ul>
Engine control system	Switch off.
Air intake and exhaust system	Out-of-service period > 1 week: Seal off engine's intake and exhaust systems. Out-of-service period > 1 month: Corrosion-proof engine (→ MTU Corrosion-proofing and Reproofing Regulations A001070/..).

## 4.7 Cleaning the plant

### Preconditions

- ☒ Engine shut down and secured against being restarted.
- ☒ Power supply not connected.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Steam jet cleaner	-	1
Cleaning agent (Hakupur 312)	30390	1

#### WARNING



Compressed air gun ejects a jet of pressurized air.

**Risk of injury to eyes and damage to hearing, risk of rupturing internal organs.**

- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

#### WARNING



Steam jet cleaner ejects jet of pressurized water.

**Risk of injury to eyes and scalding.**

- Never direct water jet at people.
- Wear protective clothing, protective gloves and safety goggles/face mask.

#### NOTICE



Cleaning agents should not be left to take effect for too long.

**Damage to components is possible.**

- Observe manufacturer's instructions.

#### NOTICE



Blowing down product with compressed air

**Entry of dirt and damage to components is possible.**

- Do not aim compressed air gun directly at seals or electronic components such as connectors or ECUs.

### Cleaning the system

1. Carry out system cleaning only in areas where an appropriate oil separator is provided (environmental protection).
2. Before starting to use the pressure/steam jet washer, read the Operating Instructions for the appliance observe the safety precautions.
3. If cleaning the outside of the system with a pressure/steam jet washer:
  - The pressure of the high-pressure jet (cleaning jet) must not exceed 50 bar.
  - A minimum distance between spray nozzle and system of 1 m must be observed.
  - The temperature of the cleaning agent must not exceed 80 °C.
4. For external cleaning with high-pressure jet, use a flat-mouth nozzle only.
5. Carry out external cleaning as follows:
  - a) Seal all openings in a suitable fashion.
  - b) Remove coarse dirt.
  - c) Spray on cleaner sparingly and leave it for 1 to 5 minutes.
  - d) Use the high-pressure jet to remove the loosened dirt.

Note: Never aim compressed air directly at electronic components.  
e) Dry engine.



## 5 Maintenance

### 5.1 Maintenance Schedule task reference table [QL1]

The maintenance tasks and intervals for this product are defined in the Maintenance Schedule. The Maintenance Schedule is a stand-alone publication.

The task numbers in this table provide reference to the maintenance tasks specified in the Maintenance Schedule.

Task	Measures	
W0500	Check engine oil level.	(→ Page 94)
W0501	Visually inspect engine for leaks and general condition.	(→ Page 33)
W0502	Check intercooler drain.	(→ Page 88)
W0503	Check signal ring position of service indicator on air filter.	(→ Page 92)
W0504	Check relief bores of HP fuel pump.	(→ Page 76)
W0505	Check relief bores of water pump(s).	(→ Page 108) (→ Page 116)
W0506	Check engine for abnormal running noises, exhaust color and vibrations.	(→ Page 33)
W0507	Drain water and contaminants from fuel prefilter.	(→ Page 85)
W0508	Check reading on differential pressure gage of fuel prefilter.	(→ Page 33)
W0525	Check generator for contamination, clean as necessary.	(→ Page 120)
W1001	Replace fuel filter or fuel filter element.	(→ Page 84)
W1003	Check belt condition and tension, replace if necessary.	(→ Page 118) (→ Page 123)
W1006	Replace fuel injectors.	(→ Page 77)
W1009	Check layer thickness of oil residue, clean and replace filter sleeve, at every oil change, at the latest.	(→ Page 101)
W1011	Perform endoscopic examination.	(→ Page 55)
W1036	Replace coolant filter.	(→ Page 110)
W1046	Crankcase breather: Replace filter or filter element.	(→ Page 59)
W1047	Check and clean oil indicator filter.	(→ Page 99)
W1164	Replace filter element and sealing ring depending on degree of contamination, when the limit (years) is reached, at the latest.	(→ See manufacturer's documentation)
W1207	Check valve clearance, adjust as necessary. ATTENTION! First adjustment after 1000 operating hours.	(→ Page 69)
W1463	Check general condition of engine mounting (visual inspection).	(→ Page 117)
W1481	Replace supplementary fuel filter or filter element of supplementary fuel filter.	(→ Page 87)
W1697	Check carbon brushes on flywheel, replace if necessary.	(→ Page 65)
W1698	Replace carbon brushes on flywheel.	(→ Page 67)
W1716	Clean generator.	(→ Page 121)

Table 1: Maintenance Schedule task reference table [QL 1]

# 6 Troubleshooting

## 6.1 Troubleshooting

### Engine does not turn over when starter is operated

Component	Cause	Action
Battery	Discharged or defective	Charge or replace (see manufacturer's documentation).
	Cable connections defective	Check if cable connections are properly secured (see manufacturer's documentation).
Starter	Engine wiring or starter faulty	Check if cable connections are properly secured, contact Service.
Engine wiring	Faulty	Check (→ Page 128).
Engine/alternator control system	Assemblies or connectors possibly loose	Perform visual inspection (see manufacturer's documentation).
Engine Control Unit	Electrical connections may be loose	Check electrical connections (→ Page 130).
Engine	Jammed (cannot be cranked by hand)	Notify Service.

### Engine turns over when started but does not fire

Component	Cause	Action
Starter	Lacks power: battery discharged or defective	Charge or replace battery (see manufacturer's documentation).
Engine wiring	Faulty	Check (→ Page 128).
Fuel system	Air in fuel system	Bleed fuel system (→ Page 83).
Engine Control Unit	Faulty	Notify Service.

### Engine fires unevenly

Component	Cause	Action
Fuel injection system	Injector defective	Replace (→ Page 77).
Engine wiring	Faulty	Check (→ Page 128).
Fuel system	Air in fuel system	Bleed fuel system (→ Page 83).
Engine Control Unit	Faulty	Notify Service.

### Engine fails to reach rated speed

Component	Cause	Action
Fuel supply	Fuel prefilter clogged	Replace
	Fuel filter clogged	Replace (→ Page 84).
Air supply	Air filter clogged	Clean.
Fuel injection system	Injector defective	Replace (→ Page 77).
Engine wiring	Faulty	Check (→ Page 128).
Engine	Overloaded	Notify Service.

## Engine speed not steady

Component	Cause	Action
Fuel injection system	Injector defective	Replace (→ Page 77).
Speed sensor	Defective	Notify Service.
Fuel system	Air in fuel system	Bleed fuel system (→ Page 83).
Engine Control Unit	Defective	Notify Service.

## Charge air temperature too high

Component	Cause	Action
Engine coolant	Incorrect coolant concentration	Check (MTU test kit).
Intercooler	Dirty	Notify Service.
Engine room	Air-intake temperature too high	Check fans and air intake/exhaust pipes.

## Charge-air pressure too low

Component	Cause	Action
Air supply	Air filter clogged	Clean.
Intercooler	Dirty	Notify Service.
Turbocharger	Defective	Notify Service.

## Coolant leakage from intercooler

Component	Cause	Action
Intercooler	Leaking, significant coolant loss	Notify Service.

## Black smoke from exhaust

Component	Cause	Action
Air supply	Air filter clogged	Clean.
Fuel injection system	Injector defective	Replace (→ Page 77).
Engine	Overloaded	Notify Service.

## Blue smoke from exhaust

Component	Cause	Action
Engine oil	Too much oil in engine	Drain engine oil (→ Page 95).
	Oil separator on crankcase venting system dirty	Replace (→ Page 59).
Turbocharger, cylinder head, piston rings, cylinder liner	Defective	Notify Service.

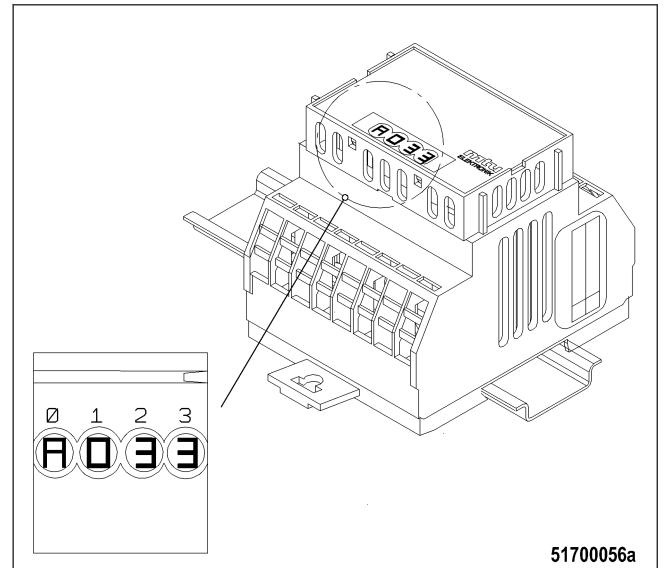
## White smoke from exhaust

Component	Cause	Action
Engine	Not at operating temperature	Run engine to reach operating temperature.
Fuel system	Water in fuel	Check fuel system at fuel prefilter

Component	Cause	Action
		Drain water from fuel prefilter.
Intercooler	Leaking	Notify Service.

## 6.2 ECU 4 alarms

Faults in the overall system are indicated as a four-digit code on the PIM display. The fault code numbers are generated by the ECU.



The four-digit code consists of one letter and three figures:

- The letter encodes when the fault occurred the last time:
  - A = currently present
  - B = within the last operating hour
  - C = one to four operating hours ago
  - D = four to twelve operating hours ago
 Alarms that occurred more than twelve hours ago are deleted automatically.
- The three figures encode the fault itself as listed in the table below.

Alarms can also be caused by defective sensors / actuators. If troubleshooting in accordance with the following table is not successful, contact Service to have the sensors / actuators checked and, if required, replaced.

Fault code	Alarm text	Meaning	Task
003	L1 T-FUEL	Fuel temperature too high (1st limit)	Reduce power.
004	L2 T-FUEL	Fuel temperature too high (2nd limit)	Reduce power.
005	L1 T-CHARGE AIR	Charge-air temperature too high (1st limit)	Reduce power.
006	L2 T-CHARGE AIR	Charge-air temperature too high (2nd limit)	Reduce power.
009	L1 T-INTERCOOLER	Charge-air coolant temperature too high (1st limit)	Reduce power.
010	L2 T-INTERCOOLER	Charge-air coolant temperature too high (2nd limit)	Reduce power.
015	L1 P-LUBE OIL	Lube-oil pressure too low (1st limit)	Check engine-oil level and top up, if required; (→ Page 94);

Fault code	Alarm text	Meaning	Task
016	L2 P-LUBE OIL	Lube-oil pressure too low (2nd limit) Automatic engine shutdown.	1. Check engine-oil level and top up, if required; (→ Page 94); 2. Try to re-start the engine (→ Page 32). 3. Contact Service.
023	L1 COOLANT LEVEL	Coolant level too low. Alarm appears together with No. 24.	Check coolant level in expansion tank.
024	L2 COOLANT LEVEL	Coolant level too low. Alarm appears together with No. 23.	Check coolant level in expansion tank.
025	L1 P-OILFILTER DIFF.	Oil filter pressure differential too high	Check oil filter.
030	ENGINE OVERSPEED	Engine overspeed. Automatic engine shutdown.	1. Acknowledge alarm. 2. Try to re-start the engine (→ Page 32). 3. Contact Service.
031	ETC CHARGER 1 OVERSPEED 1	ETC 1 – overspeed (1st limit)	Contact Service:
032	ETC CHARGER 1 OVERSPEED 2	ETC 1 – overspeed (2nd limit)	Contact Service.
036	ETC 2 CHARGER 2 OVERSPEED 1	ETC 2 – overspeed (1st limit)	Contact Service.
037	ETC 2 CHARGER 2 OVERSPEED 2	ETC 2 – overspeed (2nd limit)	Contact Service.
051	L1 T-LUBE OIL	Lube oil temperature too high (1st limit)	Reduce power.
052	L2 T-LUBE OIL	Lube oil temperature too high (2nd limit)	1. Reduce power. 2. If fault occurs repeatedly: Contact Service.
053	L1 T-INTAKE AIR	Intake air temperature too high (1st limit).	Reduce power.
054	L2 T-INTAKE AIR	Intake air temperature too high (2nd limit).	Reduce power.
057	L1 P-COOLANT	Coolant pressure too low (1st limit)	Check coolant circuit.
058	L2 P-COOLANT	Coolant pressure too low (2nd limit)	Check coolant circuit.
059	L1 P-INTERCOOLER	Charge-air coolant pressure too low (1st limit)	Check coolant circuit.
060	L2 P-INTERCOOLER	Charge-air coolant pressure too low (2nd limit)	Check coolant circuit.
063	L1 P-Crankcase	Crankcase pressure too high (1st limit)	Check oil separator. (→ Page 59)
064	L2 P-Crankcase	Crankcase pressure too high (2nd limit)	Replace oil separator.

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Fault code	Alarm text	Meaning	Task
065	L1 P-FUEL	Fuel supply pressure too low (1st limit)	<ol style="list-style-type: none"> <li>1. Check fuel lines for leaks; re- pair defective lines.</li> <li>2. Clean fuel prefilter</li> <li>3. Flush fuel prefilter</li> <li>4. Replace filter element of fuel prefilter.</li> <li>5. Fuel filter replacement (→ Page 84).</li> <li>6. If fault is not rectified: Contact Service.</li> </ol>
066	L2 P-FUEL	Fuel supply pressure too low (2nd limit)	<ol style="list-style-type: none"> <li>1. Check fuel lines for leaks; re- pair defective lines.</li> <li>2. Clean fuel prefilter</li> <li>3. Flush fuel prefilter</li> <li>4. Replace filter element of fuel prefilter.</li> <li>5. Fuel filter replacement (→ Page 84).</li> <li>6. If fault is not rectified: Contact Service.</li> </ol>
067	L1 T-COOLANT	Coolant temperature too high (1st limit). Warning	Reduce power.
068	L2 T-COOLANT	Coolant temperature too high (2nd limit). Automatic engine shutdown.	<ol style="list-style-type: none"> <li>1. Allow the engine to cool down.</li> <li>2. Check coolant cooler (elements etc.) and clean contaminated parts (see manufacturer's docu- mentation).</li> <li>3. Re-start the engine (→ Page 32).</li> <li>4. If fault occurs repeatedly: Con- tact Service.</li> </ol>
081	RAIL LEAKAGE	HP fuel system leaking, sys- tem contains air	Contact Service.
082	RAIL PRESSURE HIGH	Pressure in HP fuel system exceeds specified value; Solenoid valve of HP fuel control block jamming or wiring to solenoid valve de- fective	Contact Service.
083	RAIL PRESSURE LOW	Pressure in HP fuel system lower than the specified val- ue; HP fuel control block defec- tive or system leaking. NOTE: With very large generators having a run-out time of more than > 20 sec this alarm is not a relevant fault.	Contact Service.
087	L1 LEV. WATER IN FUEL	Water level in fuel prefilter too high	Check fuel prefilter
089	ENGINE SPEED LOW	Engine speed lower than 200 rpm; Automatic engine shutdown.	Re-start the engine (→ Page 32).

Fault code	Alarm text	Meaning	Task
090	IDLE SPEED LOW	Idle speed not reached within a specified period; Termination of starting procedure.	Note further alarms.
091	RUN UP SPEED LOW	Run-up speed not reached within a specified period; Termination of starting procedure.	Note further alarms.
092	START SPEED LOW	Starter speed not reached within a specified period; Termination of starting procedure.	Note further alarms.
093	PREHEAT TEMP. LIMIT2	Coolant preheating temperature too low during starting (2nd limit); Termination of starting procedure (depending on project design).	Check preheating pump / preheating system (see manufacturer's documentation).
094	PREHEAT TEMP. LIMIT1	Coolant preheating temperature too low during starting (1st limit)	Check preheating pump / preheating system (see manufacturer's documentation).
100	EDM NOT VALID	Check sum error of measuring-point data in EDM	If fault occurs repeatedly: Contact Service.
101	IDM NOT VALID	Check sum error of measuring-point data in IDM	If fault occurs repeatedly: Contact Service.
102	INVALID FUEL CONS 1	Check sum error of accumulated fuel consumption data in EDM (redundant data record 1)	Contact Service.
103	INVALID FUEL CONS 2	Check sum error of accumulated fuel consumption data in EDM (redundant data record 2)	Contact Service.
104	OP HOURS1 NOT VALID	Check sum error of hour meter data in EDM	If fault occurs repeatedly: Contact Service.
105	OP HOURS2 NOT VALID	Check sum error of hour meter data in IDM	If fault occurs repeatedly: Contact Service.
106	ERR REC1 NOT VALID	Check sum error of fault memory in EDM (redundant data record 1)	If fault occurs repeatedly: Contact Service.
107	ERR REC2 NOT VALID	Check sum error of fault memory in EDM (redundant data record 2)	If fault occurs repeatedly: Contact Service.
118	L1 SUPPLY VOLT. LOW	Supply voltage too low (1st limit)	Check ECU supply voltage.
119	L2 SUPPLY VOLT. LOW	Supply voltage too low (2nd limit)	Check ECU supply voltage.
120	L1 SUPPLY VOLT. HIGH	Supply voltage too high (1st limit)	Check ECU supply voltage.
121	L2 SUPPLY VOLT. HIGH	Supply voltage too high (2nd limit);	Check ECU supply voltage. If engine was stopped: Start engine (→ Page 32).



Fault code	Alarm text	Meaning	Task
		Automatic engine shutdown (depending on project design).	
122	L1 T-ELECTRONIC	Temperature in ECU housing too high (1st limit)	1. Improve engine room ventilation. 2. Reduce engine power.
134	15V POS ECU DEFECT	Electronic equipment defective; Automatic engine shutdown.	Contact Service.
136	15V NEG ECU DEFECT	Electronic equipment defective; Automatic engine shutdown.	Contact Service.
137	L1 5V BUFFER TEST	Power supply for pressure sensors defective	1. Disconnect connectors X2 and X3 from ECU. If alarm does not disappear: Contact Service. 2. Check wiring (pressure sensors). 3. Contact Service.
138	SENSORPOWERDEFECT	Power supply for pressure sensors defective	1. Disconnect connectors X2 and X3 from ECU. If alarm does not disappear: Contact Service. 2. Check wiring (pressure sensors). 3. Contact Service.
139	L1 TE BUFFER TEST	Internal electronic fault (temperature sensors)	Contact Service.
140	TE BUF. ECU DEFECT	Internal electronic fault (temperature sensors)	Contact Service.
142	BANK1 ECU DEFECT	Internal electronic fault; Engine does not start	Contact Service.
144	BANK2 ECU DEFECT	Internal electronic fault; Engine does not start.	Contact Service.
145	15V_GOOD ECU DEFECT	Electronic equipment defective; Automatic engine shutdown.	Contact Service.
146	L1 AD-TEST1 SUPPLY	A/D-converter supply voltage too low.	Contact Service.
147	AD-TEST1 ECU DEFECT	Electronic equipment defective; Automatic engine shutdown.	Contact Service.
148	L1 AD-TEST2 SUPPLY	A/D-converter supply voltage too low.	Contact Service.
149	AD-TEST2 ECU DEFECT	Electronic equipment defective; Automatic engine shutdown.	Contact Service.
150	L1 AD-TEST3 SUPPLY	A/D-converter supply voltage too low.	Contact Service.
151	AD-TEST3 ECU DEFECT	Electronic equipment defective; Automatic engine shutdown.	Contact Service.

Fault code	Alarm text	Meaning	Task
170	MI MODULE FAIL	Module in maintenance predictor either defective or missing.	Contact Service.
171	MI NOT ACTIVE	Maintenance predictor no more activated	Contact Service.
173	MODULE WRITE LIMIT	EEPROM write limit reached.	Contact Service.
180	CAN1 NODE LOST	At least one device not detected on Default CAN bus.	1. Check wiring (CAN bus). 2. Contact Service.
181	CAN2 NODE LOST	At least one device not detected on Redundant CAN bus.	1. Check wiring (CAN bus). 2. Contact Service.
183	CAN NO PU-DATA	Error during loading of CAN project design data into ECU.	Contact Service.
184	CAN PU-DATA EE-FAIL	Error during project design data download in EEPROMs.	Contact Service.
185	CAN LESS MAILBOXES	Error during CAN initialization.	Contact Service.
186	CAN1 BUS OFF	Severe fault on Default CAN bus; automatic change-over to Redundant CAN bus	Contact Service.
187	CAN1 ERROR PASSIVE	Light fault on Default CAN bus (e.g. short-time overload)	(none)
188	CAN2 BUS OFF	Severe fault on Redundant CAN bus; Automatic change-over to Default CAN bus.	Contact Service.
189	CAN2 ERROR PASSIVE	Light fault on Redundant CAN bus (e.g. short-time overload)	(none)
201	SD T-COOLANT	Sensor defect (coolant temperature)	1. Check wiring. 2. Contact Service.
202	SD T-FUEL	Sensor defect (fuel temperature)	1. Check wiring. 2. Contact Service.
203	SD T-CHARGE AIR	Sensor defect (charge-air temperature)	1. Check wiring. 2. Contact Service.
205	SD T-COOLANT INTERC.	Sensor defect (charge-air coolant temperature)	1. Check wiring. 2. Contact Service.
208	SD P-CHARGE AIR	Sensor defect (charge-air pressure)	1. Check wiring. 2. Contact Service.
211	SD P-LUBE OIL	Sensor defect (lube oil pressure)	1. Check wiring. 2. Contact Service.
212	SD P-COOLANT	Sensor defect (coolant pressure)	1. Check wiring. 2. Contact Service.
213	SD P-COOLANT INTERC.	Sensor defect (intercooler coolant pressure)	1. Check wiring. 2. Contact Service.
214	SD P-CRANKCASE	Sensor defect (crankcase pressure)	1. Check wiring. 2. Contact Service.

TIM-ID: 0000003161 - 001

Fault code	Alarm text	Meaning	Task
215	SD P-RAIL FUEL	Sensor defect (common rail pressure); HP controller in emergency mode.	1. Check wiring. 2. Contact Service.
216	SD T-LUBE OIL	Sensor defect (lube oil temperature)	1. Check wiring. 2. Contact Service.
219	SD T-INTAKE AIR	Sensor defect (intake-air temperature)	1. Check wiring. 2. Contact Service.
220	SD COOLANT LEVEL	Sensor defect (coolant level)	1. Check wiring. 2. Contact Service.
221	SD P-OILFILTER DIFF	Sensor defect (lube oil pressure differential)	1. Check wiring 2. Contact Service.
226	SD WATER IN FUEL	Sensor defect (water in fuel prefilter)	1. Check wiring 2. Contact Service.
229	SD ENG.SPEED SENSORS	Sensor defect (crankshaft speed) and sensor defect (camshaft speed)	1. Check wiring. 2. Contact Service.
230	SD CRANKSHAFT SPEED	Sensor defect (crankshaft speed)	1. Check wiring. 2. Contact Service.
231	SD CAMSHAFT SPEED	Sensor defect (camshaft speed)	1. Check wiring. 2. Contact Service.
232	SD ETC SPEED 11	Sensor defect (turbocharger speed)	1. Check wiring. 2. Contact Service.
240	SD P-FUEL	Sensor defect (fuel pressure)	1. Check wiring. 2. Contact Service.
245	SD POWER SUPPLY	Sensor defect (ECU operating voltage)	Contact Service.
246	SD T-ELECTRONIC	Sensor defect (temperature in ECU)	Contact Service.
266	SD SPEED DEMAND AN.	Sensor defect (analog speed demand)	1. Check speed transmitter 2. Check wiring. 3. Contact Service.
301	TIMING CYLINDER A1	Injection timing fault cylinder A1	If fault occurs repeatedly: Contact Service.
302	TIMING CYLINDER A2	Injection timing fault cylinder A2	If fault occurs repeatedly: Contact Service.
303	TIMING CYLINDER A3	Injection timing fault cylinder A3	If fault occurs repeatedly: Contact Service.
304	TIMING CYLINDER A4	Injection timing fault cylinder A4	If fault occurs repeatedly: Contact Service.
305	TIMING CYLINDER A5	Injection timing fault cylinder A5	If fault occurs repeatedly: Contact Service.
306	TIMING CYLINDER A6	Injection timing fault cylinder A6	If fault occurs repeatedly: Contact Service.
307	TIMING CYLINDER A7	Injection timing fault cylinder A7	If fault occurs repeatedly: Contact Service.
308	TIMING CYLINDER A8	Injection timing fault cylinder A8	If fault occurs repeatedly: Contact Service.
309	TIMING CYLINDER A9	Injection timing fault cylinder A9	If fault occurs repeatedly: Contact Service.

Fault code	Alarm text	Meaning	Task
310	TIMING CYLINDER A10	Injection timing fault cylinder A10	If fault occurs repeatedly: Contact Service.
311	TIMING CYLINDER B1	Injection timing fault cylinder B1	If fault occurs repeatedly: Contact Service.
312	TIMING CYLINDER B2	Injection timing fault cylinder B2	If fault occurs repeatedly: Contact Service.
313	TIMING CYLINDER B3	Injection timing fault cylinder B3	If fault occurs repeatedly: Contact Service.
314	TIMING CYLINDER B4	Injection timing fault cylinder B4	If fault occurs repeatedly: Contact Service.
315	TIMING CYLINDER B5	Injection timing fault cylinder B5	If fault occurs repeatedly: Contact Service.
316	TIMING CYLINDER B6	Injection timing fault cylinder B6	If fault occurs repeatedly: Contact Service.
317	TIMING CYLINDER B7	Injection timing fault cylinder B7	If fault occurs repeatedly: Contact Service.
318	TIMING CYLINDER B8	Injection timing fault cylinder B8	If fault occurs repeatedly: Contact Service.
319	TIMING CYLINDER B9	Injection timing fault cylinder B9	If fault occurs repeatedly: Contact Service.
320	TIMING CYLINDER B10	Injection timing fault cylinder B10	If fault occurs repeatedly: Contact Service.
321	WIRING CYLINDER A1	Faulty wiring to solenoid valve cylinder A1; Misfiring	1. Check wiring. 2. Contact Service.
322	WIRING CYLINDER A2	Faulty wiring to solenoid valve cylinder A2; Misfiring	1. Check wiring. 2. Contact Service.
323	WIRING CYLINDER A3	Faulty wiring to solenoid valve cylinder A3; Misfiring	1. Check wiring. 2. Contact Service.
324	WIRING CYLINDER A4	Faulty wiring to solenoid valve cylinder A4; Misfiring	1. Check wiring. 2. Contact Service.
325	WIRING CYLINDER A5	Faulty wiring to solenoid valve cylinder A5; Misfiring	1. Check wiring. 2. Contact Service.
326	WIRING CYLINDER A6	Faulty wiring to solenoid valve cylinder A6; Misfiring	1. Check wiring. 2. Contact Service.
327	WIRING CYLINDER A7	Faulty wiring to solenoid valve cylinder A7; Misfiring	1. Check wiring. 2. Contact Service.
328	WIRING CYLINDER A8	Faulty wiring to solenoid valve cylinder A8; Misfiring	1. Check wiring. 2. Contact Service.
329	WIRING CYLINDER A9	Faulty wiring to solenoid valve cylinder A9; Misfiring	1. Check wiring. 2. Contact Service.

Fault code	Alarm text	Meaning	Task
330	WIRING CYLINDER A10	Faulty wiring to solenoid valve cylinder A10; Misfiring	1. Check wiring 2. Contact Service.
331	WIRING CYLINDER B1	Faulty wiring to solenoid valve cylinder B1; Misfiring	1. Check wiring. 2. Contact Service.
332	WIRING CYLINDER B2	Faulty wiring to solenoid valve cylinder B2; Misfiring	1. Check wiring. 2. Contact Service.
333	WIRING CYLINDER B3	Faulty wiring to solenoid valve cylinder B3; Misfiring	1. Check wiring. 2. Contact Service.
334	WIRING CYLINDER B4	Faulty wiring to solenoid valve cylinder B4; Misfiring	1. Check wiring. 2. Contact Service.
335	WIRING CYLINDER B5	Faulty wiring to solenoid valve cylinder B5; Misfiring	1. Check wiring. 2. Contact Service.
336	WIRING CYLINDER B6	Faulty wiring to solenoid valve cylinder B6; Misfiring	1. Check wiring. 2. Contact Service.
337	WIRING CYLINDER B7	Faulty wiring to solenoid valve cylinder B7; Misfiring	1. Check wiring. 2. Contact Service.
338	WIRING CYLINDER B8	Faulty wiring to solenoid valve cylinder B8; Misfiring	1. Check wiring. 2. Contact Service.
339	WIRING CYLINDER B9	Faulty wiring to solenoid valve cylinder B9; Misfiring	1. Check wiring. 2. Contact Service.
340	WIRING CYLINDER B10	Faulty wiring to solenoid valve cylinder B10; Misfiring	1. Check wiring. 2. Contact Service.
341	OPEN_LOAD CYL. A1	Disconnection in wiring to solenoid valve cylinder A1; Misfiring	1. Check wiring. 2. Contact Service.
342	OPEN_LOAD CYL. A2	Disconnection in wiring to solenoid valve cylinder A2; Misfiring	1. Check wiring. 2. Contact Service.
343	OPEN_LOAD CYL. A3	Disconnection in wiring to solenoid valve cylinder A3; Misfiring	1. Check wiring. 2. Contact Service.
344	OPEN_LOAD CYL. A4	Disconnection in wiring to solenoid valve cylinder A4; Misfiring	1. Check wiring. 2. Contact Service.
345	OPEN_LOAD CYL. A5	Disconnection in wiring to solenoid valve cylinder A5; Misfiring	1. Check wiring. 2. Contact Service.
346	OPEN_LOAD CYL. A6	Disconnection in wiring to solenoid valve cylinder A6; Misfiring	1. Check wiring. 2. Contact Service.

Fault code	Alarm text	Meaning	Task
347	OPEN_LOAD CYL. A7	Disconnection in wiring to solenoid valve cylinder A7; Misfiring	1. Check wiring. 2. Contact Service.
348	OPEN_LOAD CYL. A8	Disconnection in wiring to solenoid valve cylinder A8; Misfiring	1. Check wiring. 2. Contact Service.
349	OPEN_LOAD CYL. A9	Disconnection in wiring to solenoid valve cylinder A9; Misfiring	1. Check wiring. 2. Contact Service.
350	OPEN_LOAD CYL. A10	Disconnection in wiring to solenoid valve cylinder A10; Misfiring	1. Check wiring. 2. Contact Service.
351	OPEN_LOAD CYL. B1	Disconnection in wiring to solenoid valve cylinder B1; Misfiring	1. Check wiring. 2. Contact Service.
352	OPEN_LOAD CYL. B2	Disconnection in wiring to solenoid valve cylinder B2; Misfiring	1. Check wiring. 2. Contact Service.
353	OPEN_LOAD CYL. B3	Disconnection in wiring to solenoid valve cylinder B3; Misfiring	1. Check wiring. 2. Contact Service.
354	OPEN_LOAD CYL. B4	Disconnection in wiring to solenoid valve cylinder B4; Misfiring	1. Check wiring. 2. Contact Service.
355	OPEN_LOAD CYL. B5	Disconnection in wiring to solenoid valve cylinder B5; Misfiring	1. Check wiring. 2. Contact Service.
356	OPEN_LOAD CYL. B6	Disconnection in wiring to solenoid valve cylinder B6; Misfiring	1. Check wiring. 2. Contact Service.
357	OPEN_LOAD CYL. B7	Disconnection in wiring to solenoid valve cylinder B7; Misfiring	1. Check wiring. 2. Contact Service.
358	OPEN_LOAD CYL. B8	Disconnection in wiring to solenoid valve cylinder B8; Misfiring	1. Check wiring. 2. Contact Service.
359	OPEN_LOAD CYL. B9	Disconnection in wiring to solenoid valve cylinder B9; Misfiring	1. Check wiring 2. Contact Service.
360	OPEN_LOAD CYL. B10	Disconnection in wiring to solenoid valve cylinder B10; Misfiring	1. Check wiring 2. Contact Service:
361	POWER STAGE FAIL 1	Defect in ECU (solenoid valve power stage)	Contact Service.
362	POWER STAGE FAIL 2	Defect in ECU (solenoid valve power stage)	Contact Service.
363	STOP POWER STAGE 1	Solenoid valve or wiring or ECU defective Automatic engine shutdown.	1. Check wiring. 2. Try to re-start the engine (→ Page 32). 3. Contact Service.

Fault code	Alarm text	Meaning	Task
364	STOP POWER STAGE 2	Solenoid valve or wiring or ECU defective Automatic engine shutdown.	1. Check wiring. 2. Try to re-start the engine (→ Page 32). 3. Contact Service.
365	STOP SOLENOID-WIR- ING	Solenoid-valve wiring faulty; Automatic engine shutdown.	1. Check wiring. 2. Try to re-start the engine (→ Page 32). 3. Contact Service.
381	TRAN.OUT1 PLANT DEF	Binary transistor output plant 1 defective	Contact Service.
382	TRAN.OUT2 PLANT DEF	Binary transistor output plant 2 defective	Contact Service.
383	TRAN.OUT3 PLANT DEF	Binary transistor output plant 3 defective	Contact Service.
384	TRAN.OUT4 PLANT DEF	Binary transistor output plant 4 defective	Contact Service.
385	TRAN.OUT 5 PLANT DEF	Binary transistor output plant 5 defective	Contact Service.
386	TRAN.OUT 6 PLANT DEF	Binary transistor output plant 6 defective	Contact Service.

## 7 Task Description

### 7.1 Engine

#### 7.1.1 Engine - Barring manually

##### Preconditions

- ☑ Engine is stopped and starting disabled.

##### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Barring gear	F6555766	1
Barring gear	F6783293	1
Adapter	F6558528	1
Ratchet with extension	F30006212	1

DANGER



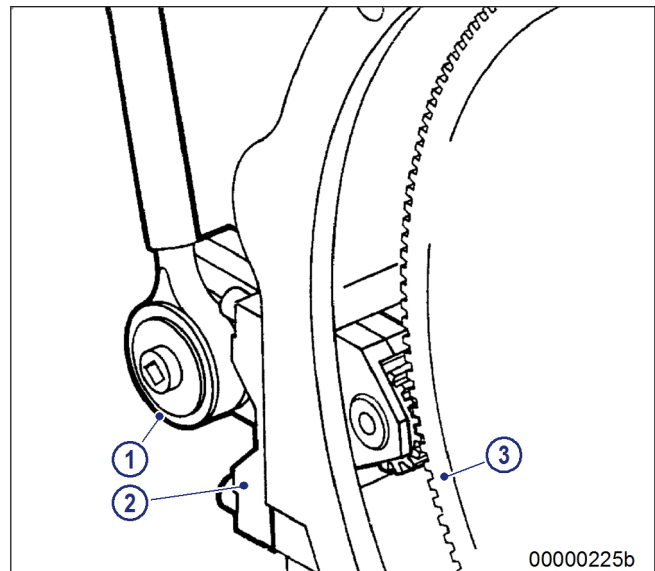
Rotating and moving engine parts.

**Risk of crushing, danger of parts of the body being caught or pulled in.**

- Before cranking the engine with starter system, make sure that there are no persons in the engine's danger zone.

##### Barring engine manually (tool mounted on side)

1. Remove guard plate.
2. Engage barring gear (2) in ring gear (3) and mount on flywheel housing.
  - Use barring gear F6555766.
3. Fit ratchet (1) onto barring gear (2).
4. Rotate crankshaft in normal direction of engine rotation; apart from the normal compression resistance, there should be no resistance.
5. Barring gear is removed by same procedure in reverse.

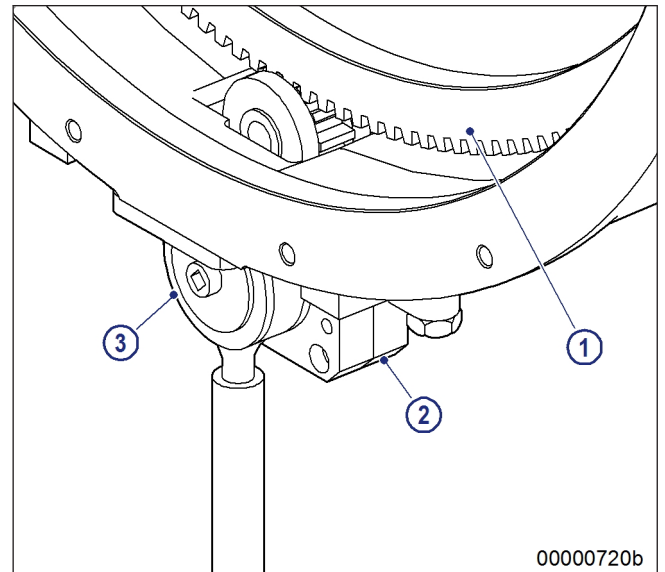


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### Barring engine manually (tool mounted underneath)

1. Remove grounding device or guard plate.
2. Engage barring gear (2) in ring gear (1) and mount on flywheel housing.
  - For 12/16V engines, use barring gear F6555766 with adapter F6558528.
  - For 20V engines, use barring gear F6783293.
3. Fit ratchet (3) onto barring gear (2).
4. Rotate crankshaft in normal direction of engine rotation; apart from the normal compression resistance, there should be no resistance.
5. Barring gear is removed by same procedure in reverse.



## 7.1.2 Engine - Barring with starting system

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1

#### DANGER



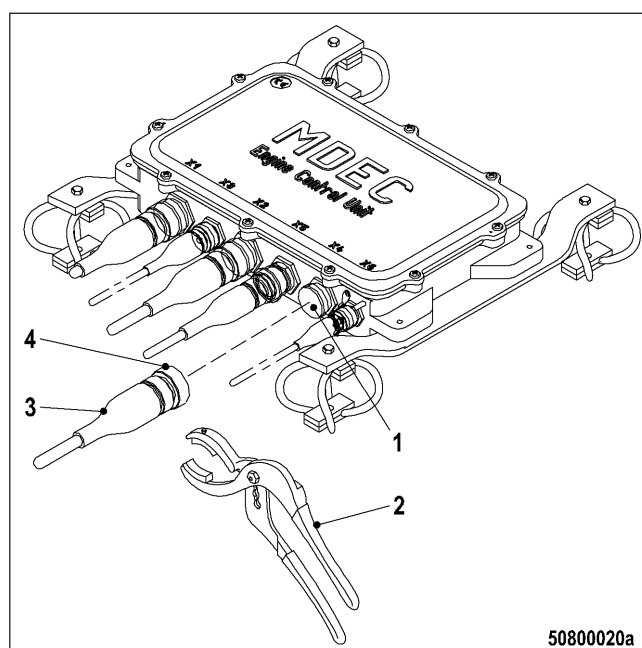
Rotating and moving engine parts.

**Risk of crushing, danger of parts of the body being caught or pulled in.**

- Before cranking the engine, make sure that there are no persons in the engine's danger zone.
- After finishing work on the engine, make sure that all safety devices are put back in place and all tools removed from the engine.

### Barring engine with starting system

1. Disengage the bayonet coupling (4) of connector X4 with connector pliers (2) and withdraw connector (3) from engine governor.
2. Bar engine in unloaded condition: Press START button.
3. Let the crankshaft rotate until oil pressure is indicated.
4. Engine start is automatically interrupted when specified starting period is expired. If necessary, re-start the engine after approx. 20 seconds.
5. Plug connector X4 (3) and use connector pliers (2) to secure the bayonet coupling (4) by turning it clockwise until it latches into place.



## 7.2 Cylinder Liner

### 7.2.1 Endoscopically examining cylinder liner

#### Preconditions

- ☑ Engine shut down and secured against being restarted.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cranking tool	F6555766	1
Ratchet with extension	F30006212	1
Endoscope	Y20097353	1

#### Preparatory steps

1. Remove cylinder head cover (→ Page 74).
2. Remove injector (→ Page 78).

#### Positioning crankshaft at BDC

1. Using cranking tool, turn crankshaft until crankpin of the cylinder to be tested has reached BDC.
2. Insert endoscope into cylinder liner through injector socket.

#### Endoscopically examining cylinder liner

Findings	Action
<ul style="list-style-type: none"><li>• Thin carbon coating around carbon scraper ring</li><li>• Slight localized additive deposits at top edge</li><li>• Localized polished areas at bottom edge</li><li>• Ring of carbon around entire circumference between top piston ring and bottom edge of carbon scraper ring</li><li>• First signs of marks left by top piston ring</li><li>• Light traces around circumference</li><li>• Faultless, even honing pattern</li><li>• First signs of marks left by lower cooling bores</li><li>• Wear pattern appears darker</li></ul>	No action required.
<ul style="list-style-type: none"><li>• Dark areas with even or varying degrees of discoloration</li><li>• Beginning and end of the discoloration are not sharply defined and do not cover the entire stroke length</li><li>• Dark areas in the upper section of the cooling bore, remaining circumference cannot be faulted</li><li>• Piston rings cannot be faulted</li></ul>	Further endoscopic examination required as part of maintenance work.
<ul style="list-style-type: none"><li>• Around the entire circumference, as well as areas of pale discoloration (not such as to impair operation) clearly darker stripes that start at the top piston ring</li><li>• Heat discoloration in the direction of stroke and honing pattern damage</li><li>• Heat discoloration of piston rings</li></ul>	Cylinder liner must be replaced; contact Service

1. Compile endoscopy report with the aid of the table.
2. Use technical terms for description of the liner surface (→ Page 57).
3. Depending on findings:
  - Do not take any action or
  - carry out a further endoscopic examination as part of maintenance work or
  - contact Service; cylinder liner must be replaced.

### **Final steps**

1. Refit injector (→ Page 78).
2. Install cylinder head cover (→ Page 74).

## 7.2.2 Instructions and comments on endoscopic and visual examination of cylinder liners

### Terms used for endoscopic examination

Use the terms listed below to describe the condition of the cylinder-liner surface in the endoscopic examination report.

Findings	Measure
Light scoring	Minor dirt scores can occur during the assembly of a new engine (honing products, particles, broken-off burrs). Removed cylinders clearly exhibit such scoring on the running surface under endoscope magnification. Cannot be felt with the fingernail. Findings not critical.
Single scores	Clearly visible scores caused by hard particles. They usually start in the TDC area and cross through the honing pattern in the direction of stroke. Findings not critical.
Scored area	These areas consist of scores of different lengths and depths next to one another. In most cases, they are found at the 6-o'clock and 12-o'clock positions (inlet/exhaust) along the transverse engine axis. Findings not critical.
Smoothened area	Smoothened areas are changes to the running surface but almost the whole honing pattern is still visible. Smoothened areas appear brighter and more brilliant than the surrounding running surface. Findings not critical.
Polished area	Polished areas are on the running surface and show local removal of the honing pattern. Grooves from the honing process are not visible any more. New cylinder liners must be fitted in the following cases Polished area: covers more than 20% of the entire piston running surface, covers more than 30° of the circumference and extends over more than 50% of piston stroke, is wider than 15 mm over the entire piston stroke.
Discoloration	This is caused by oxidation (surface discoloration through oil or fuel) and temperature differences around the liner. It appears rather darker within the honed structure in contrast to the bright metallic running surface. The honing pattern is undisturbed. Discolorations extend in stroke direction and may be interrupted. Findings not critical.
Corrosion fields / spots	Corrosion fields / spots result from water (condensed water) with the valves in the overlap (open) position. They are clearly visible due to the dark color of the honing groove bottom. This corrosion is not critical unless there is corrosion pitting.
Black lines	Black lines are a step towards heat discoloration. They are visible as a clear discoloration from TDC to BDC in the running surface and the start of localized damage to the honing pattern. Cylinders with a number of black lines around the running surface have limited service life and should be replaced.
Discolorations (Heat)	These are caused by a disturbance in the liner / ring tribosystem. Usually they run over the whole ring-travel area (TDC/BDC), starting at the first TDC-ring and becoming more visible from the second TDC-ring onwards and less pronounced from TDC-ring 1. The honing pattern is usually no longer visible and displays a clearly defined (straight) edge to the undisturbed surface. The damaged surface is usually discolored. The circumferential length varies.

Findings	Measure
	Liners with heat discoloration starting in the TDC-ring 1 have to be replaced.
Seizures, Seizure marks	Seizure marks are of irregular circumferential length and depth. Can be caused by either the piston skirt or the piston crown. Material deposits on the liner (smears) show heavy discoloration and scoring. Replace liner.

### Evaluation of findings and further measures

The findings in the start phase of oxidation discoloration and heat discoloration are similar. Thorough investigation and compliance with the above evaluation criteria allows a definite evaluation. To avoid unnecessary disassembly work, it is recommended that another inspection be carried out after further operation of the engine.

## 7.3 Crankcase Breather

### 7.3.1 Crankcase breather – Oil separator element replacement, diaphragm check and replacement

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 6-50 Nm	F30027336	1
Ratchet	F30027340	1
Engine oil		
Filter element	(→ Spare Parts Catalog)	
Diaphragm	(→ Spare Parts Catalog)	
Gasket	(→ Spare Parts Catalog)	

#### WARNING



Hot oil.

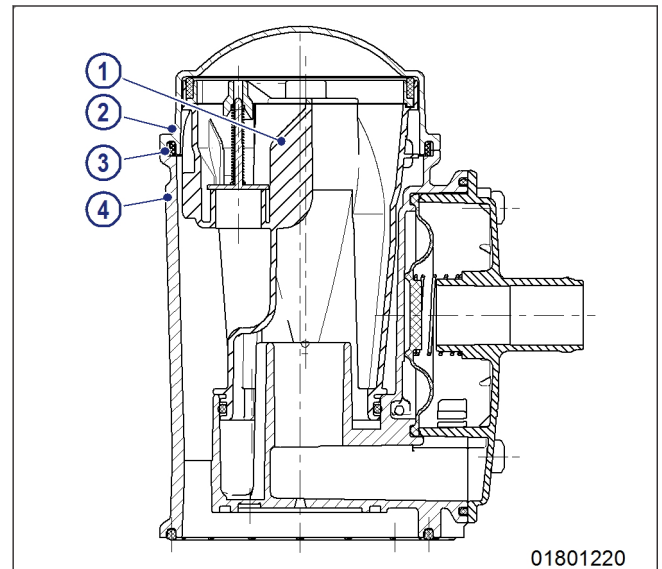
Oil can contain combustion residues which are harmful to health.

#### Risk of injury and poisoning!

- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

#### Replacing oil separator element

1. Remove cover (2) with O-ring (3).
2. Remove filter element (1) from housing (4).
3. Insert new filter element in housing (4).
4. Install cover (2) with new O-ring.



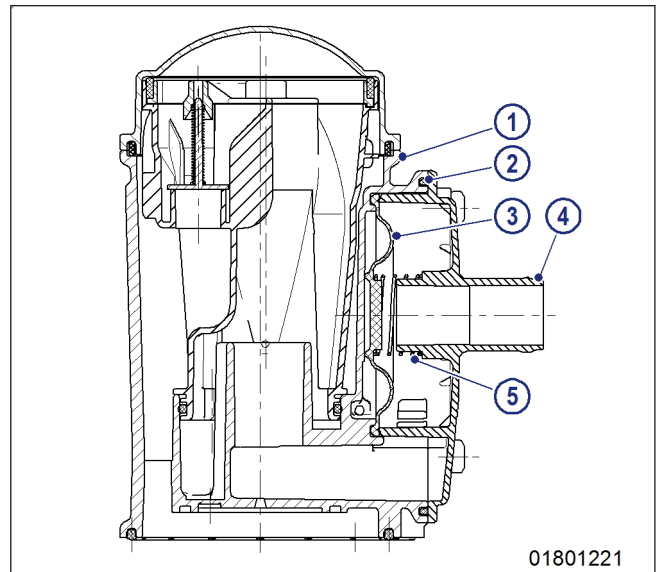
5. Use torque wrench to tighten the screws of cover (2) to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	10 Nm – 2 Nm

6. Replace further oil separator elements in the same way.

## Checking diaphragm

1. Remove cover (4).
2. Remove spring (5), gasket (2) and diaphragm (3).
3. Check diaphragm (3) for damage, fit new diaphragm if used one is damaged.
4. Install diaphragm (3) on housing (1).
5. Install new seal (2) and spring (5) together with cover (4).



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6. Use torque wrench to tighten the screws of cover (4) to the specified torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque	(Engine oil)	10 Nm –2 Nm

7. Check diaphragms in further oil separators in the same way.



### 7.3.2 Crankcase breather – Cleaning

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cleaner (Snow-White 11-0)	40460	1
Cleaner (Hakupur 312)	30390	1

#### WARNING



Compressed air gun ejects a jet of pressurized air.

**Risk of injury to eyes and damage to hearing, risk of rupturing internal organs.**

- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

#### WARNING



Cleaner is extremely caustic.

**Risk of injury and suffocation!**

- Avoid contact with eyes and skin.
- Do not inhale vapors and smoke.
- Do not eat, drink, smoke when working with cleaner.
- Wear protective clothing, gloves, and goggles / safety mask.
- Take measures against electrostatic charging.

#### NOTICE



Cleaning agents should not be left to take effect for too long.

**Damage to components is possible.**

- Observe manufacturer's instructions.

#### Clean crankcase breather

Note: Protect rubber and synthetic components from oil and fuel, never treat with organic detergents. Wipe with a dry cloth only.

1. Clean all metallic parts with cleaner (Snow-White 11-0), then rinse with cleaner (Hakupur 312).
2. Blow down all parts with compressed air.

### 7.3.3 Crankcase breather (open-circuit crankcase ventilation) – Filter element cleaning

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### WARNING



Compressed air gun ejects a jet of pressurized air.

**Risk of injury to eyes and damage to hearing, risk of rupturing internal organs.**

- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

#### NOTICE



Cleaning agents should not be left to take effect for too long.

**Damage to components is possible.**

- Observe manufacturer's instructions.

#### Clean filter element

1. Remove filter element (→ Page 59).
2. Clean filter element with cleaning agent.
3. Remove cleaner.
4. Blow out filter element thoroughly with compressed air.
5. Install filter element (→ Page 59).

### 7.3.4 Crankcase breather – Filter element replacement

#### Preconditions

- ☑ Engine shut down and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 10-60Nm	F30452769	1
Engine oil		
Filter insert	(→ Spare Parts Catalog)	

#### WARNING



Hot oil.

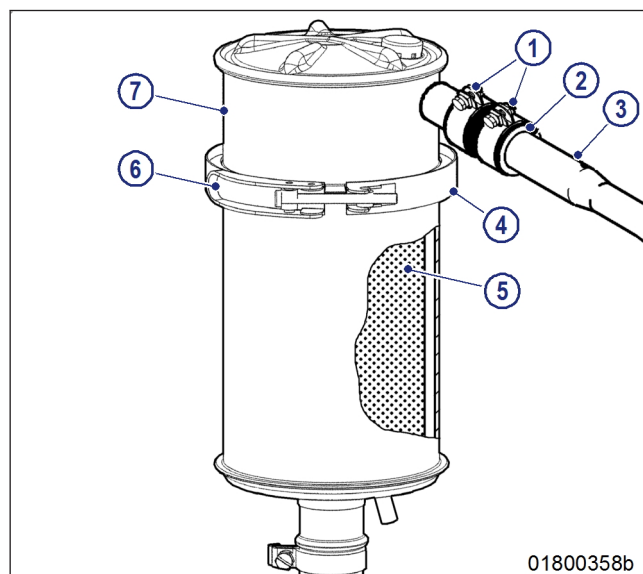
Oil can contain combustion residues which are harmful to health.

#### Risk of injury and poisoning!

- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

#### Crankcase breather (closed-circuit crankcase ventilation) – Filter element replacement

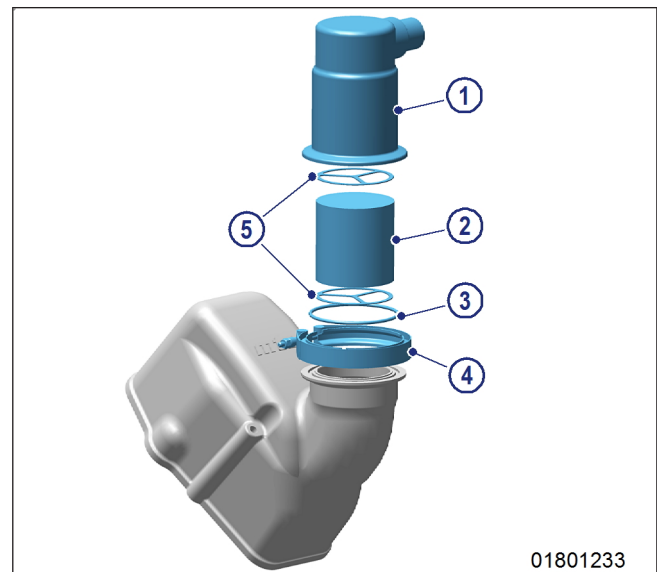
1. Loosen clamps (1), push rubber sleeves (2) over pipe (3).
2. Release band clamp (4) with lever (6).
3. Remove cover (7).
4. Replace filter element (5).
5. Fit cover (7).
6. Operate lever (6) to tension clamping band (4).
7. Push back rubber sleeve (2) and tighten clamp (1).
8. Replace further filter elements in the same way.



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### Crankcase breather (open-circuit crankcase ventilation) – Filter element cleaning or replacement

1. Clean filter externally.
2. Release vent hose on oil separator cover (1) and remove.
3. Remove oil separator cover (1).
4. Loosen clamp (5).
5. Clean or replace filter element (2) (→ Page 61).
6. Insert new sealing ring (3).
7. Install cleaned or new filter element (2) with filter holder (5).
8. Mount oil separator cover (1).



9. Tighten nut of clamp (4) with torque wrench to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque	(Engine oil)	9Nm + 1Nm

10. Push vent hose onto oil separator cover (3) and bolt on.
11. Replace further filter elements (2) in the same way.

## 7.4 Running Gear

### 7.4.1 Grounding device - Carbon brush check

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cold cleaner (Hakutex 60)	50602	
Carbon brush	(→ Spare Parts Catalog)	

#### WARNING



Compressed air gun ejects a jet of pressurized air.

**Risk of injury to eyes and damage to hearing, risk of rupturing internal organs.**

- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

#### NOTICE



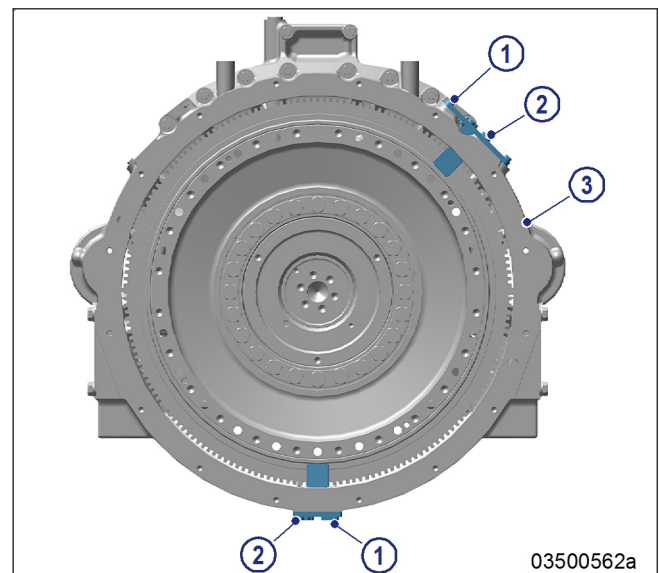
Inappropriate cleaning tool.

**Risk of damage to component!**

- Observe manufacturer's instructions.
- Use appropriate cleaning tool.

#### Remove grounding assembly

1. Remove screws (1) with washers.
2. Remove grounding device (2) from flywheel housing (3).



#### Checking grounding device

Item	Findings	Measure
Carbon brush	Damaged Wear limit 45 mm (new condition 60 mm)	Fit new part(→ Page 67) Fit new part(→ Page 67)
Press carbon brush against spring pressure Spring	broken, damaged	Fit new part(→ Page 67)
Running surface on adapter	contaminated, corroded	Clean

### **Cleaning running surface on adapter**

1. Clean running surface of carbon brushes on adapter with cold cleaner.
2. Remove stubborn deposits with soft brush.
3. Blow out adapter with compressed air.

### **Installing grounding device**

1. Check mounting surface on flywheel housing for cleanness.
2. Install grounding device on flywheel housing and secure with screws.

## 7.4.2 Grounding device – Carbon brush replacement

### Preconditions

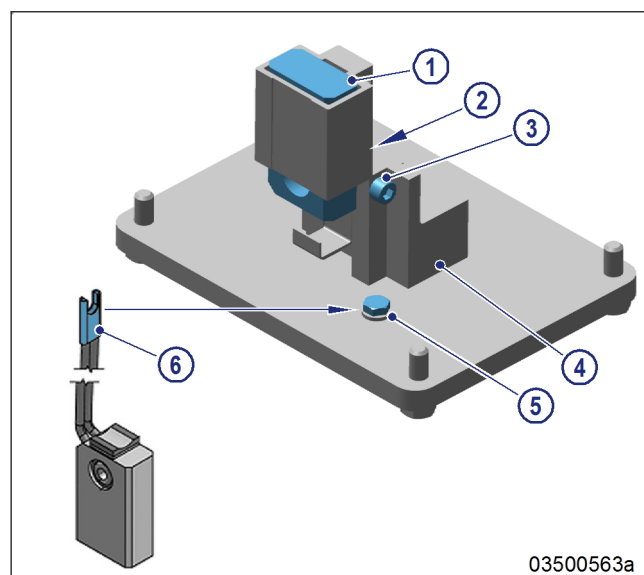
- ☑ Engine shut down and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Loctite 270	40083	
Carbon brush	(→ Spare Parts Catalog)	2

### Replace carbon brush

1. Loosen screw (5).
  2. Disconnect cable (6) from screw (5).
  3. Loosen screws (3).
  4. Remove screws (2).
  5. Remove carbon brush (1) from grounding device (4).
  6. Fit new carbon brush (1) in grounding device (4).
  7. Tighten screws (2) by hand.
  8. Insert screws (3) as far as the stop and tighten screws lightly.
  9. Tighten screws (2).
- Note: Apply Loctite 270 only to threads.
10. Secure cable (6) with screw (5).



## 7.5 Valve Drive

### 7.5.1 Valve gear – Lubrication

#### Preconditions

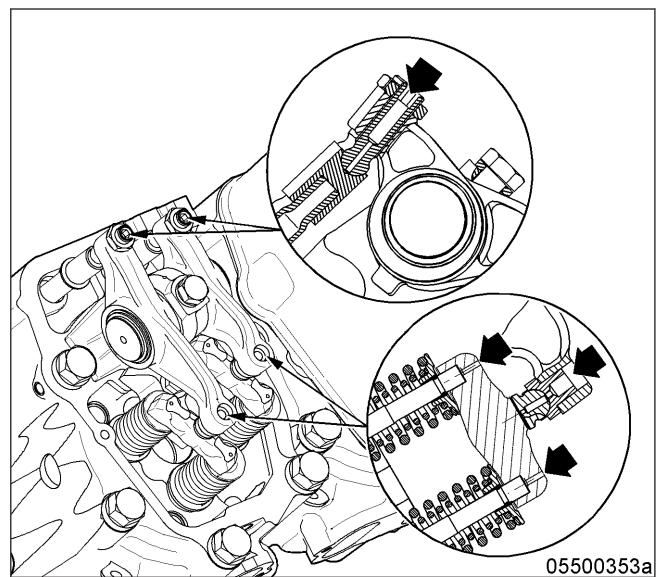
- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

#### Valve gear – Lubrication

1. Remove cylinder head covers (→ Page 74).
2. Fill oil chambers of rocker arms and adjusting screws with oil.
3. Install cylinder head covers (→ Page 74).





## 7.5.2 Valve clearance – Check and adjustment

### Preconditions

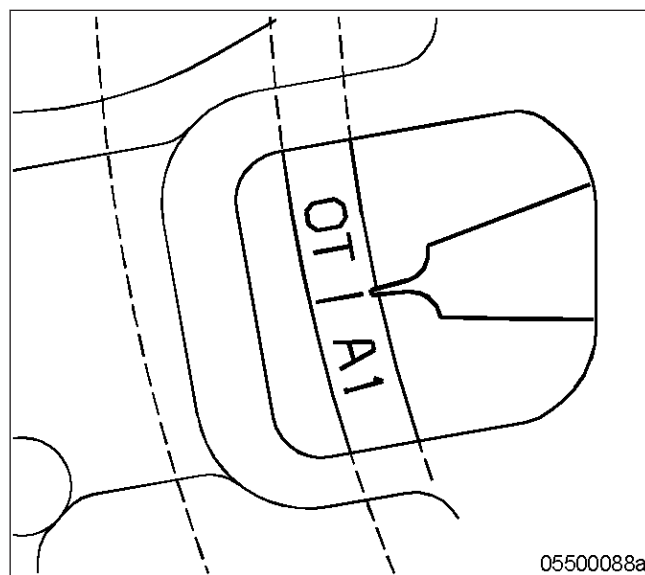
- ☒ Engine is stopped and starting disabled.
- ☒ Engine coolant temperature is max. 40 °C.
- ☒ Valves are closed.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Feeler gauge	Y20010128	1
Torque wrench 60-320 Nm	F30047446	1
Socket wrench	F30039526	1
Allen key	F30002817	1
Torque wrench 10-60 Nm	F30510423	1
Socket wrench	F30039518	1

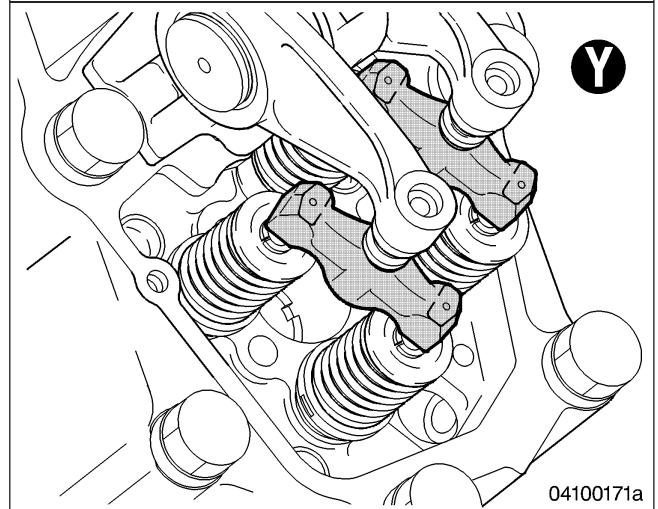
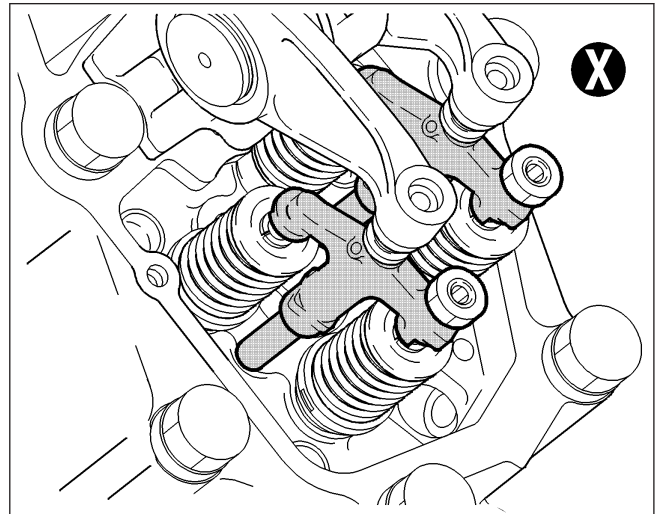
### Preparatory steps

1. Remove cylinder head cover (→ Page 74).
2. Install barring tool (→ Page 52).
3. Rotate crankshaft with barring tool in engine direction of rotation until marking "OT | A1" and pointer are aligned.

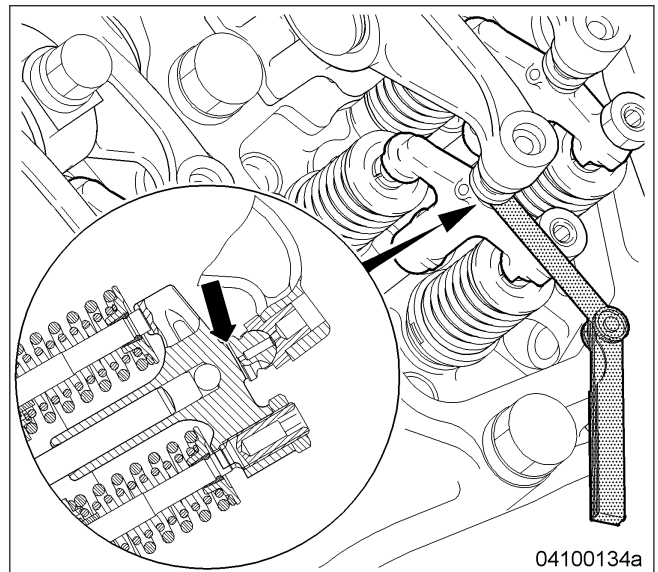


## Checking valve-bridge balance

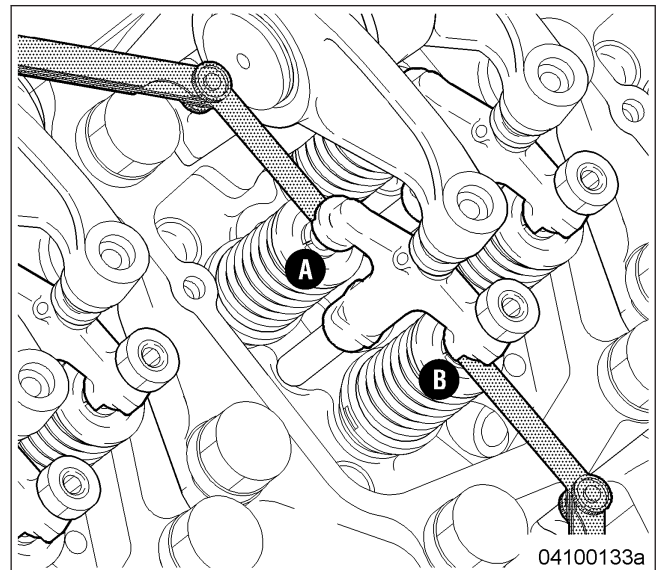
- X Valve bridge with guide
- Y Flying valve bridge



- Note: Not applicable for engines with flying valve bridge.
1. Prior to adjusting valve clearance, check valve-bridge balance on all valve bridges.
  2. Use feeler gauge to determine the distance between valve bridge and rocker arm.



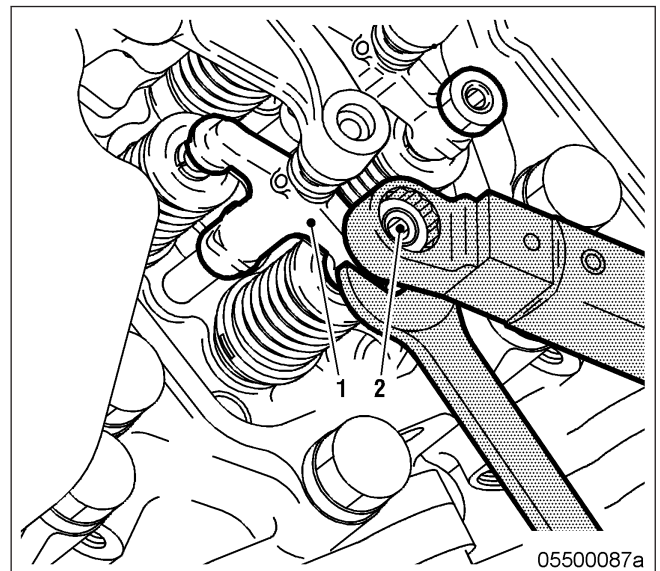
3. Insert feeler gauge with determined value between valve bridge and valve-stem end (A).
4. At the opposite valve-stem end (B), a feeler gauge thicker by 0.05 mm should not fit, otherwise adjust valve bridge balance.



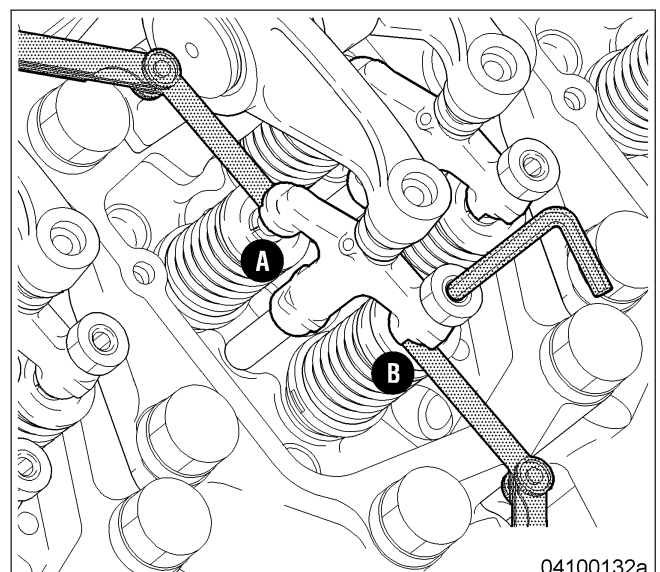
### Adjusting valve-bridge balance

Note: Not applicable for engines with flying valve bridge.

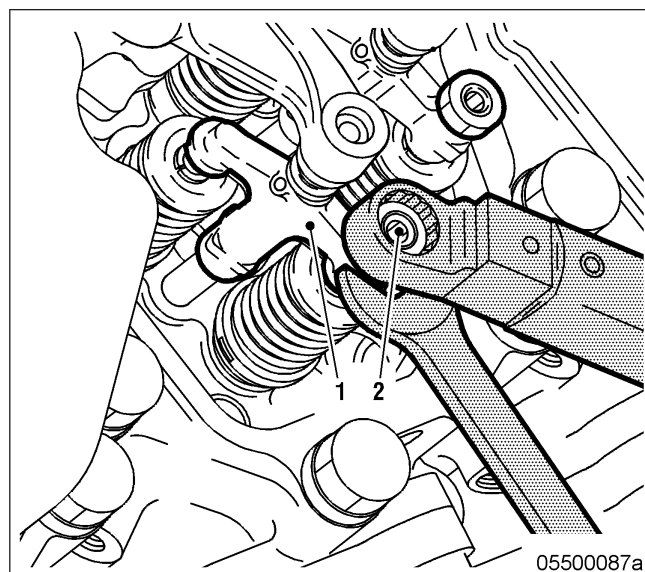
1. Hold valve bridge (1) firmly in position with open-end spanner and release locknut (2).



2. Use feeler gauge to determine the distance between valve bridge and rocker arm.
3. Place one feeler gauge (of the determined value) each between valve bridge and the two valve-stem ends (A) and (B).
4. Turn adjusting screw so that both feeler gauges can be just pulled through.
5. Hold adjusting screw securely in position with Allen key and fit locknut by hand on valve bridge.
6. Replace or rectify adjusting screws which do not move freely.



7. Tighten locknut (2) to 35 Nm +5 Nm, holding valve bridge (1) in position with open-end spanner.
8. Check valve bridge balance again.
9. Adjust valve-bridge balance at two crankshaft positions according to the following diagram.



### Checking valve clearance at two crankshaft positions

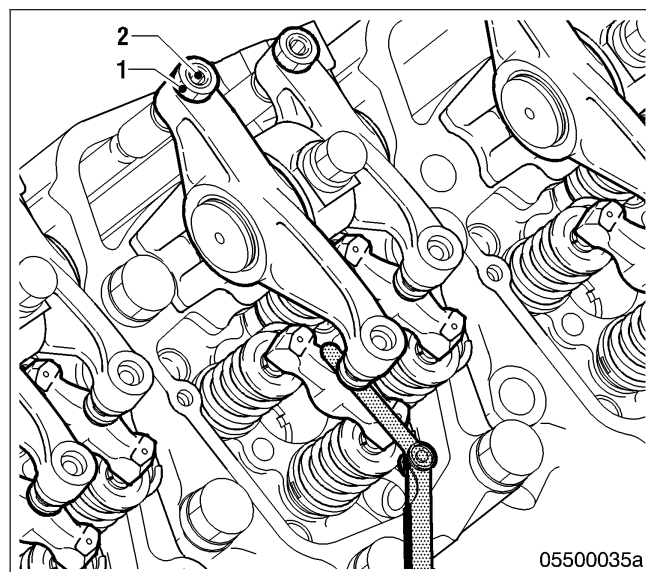
1. Check TDC position of piston in cylinder A1:
  - If the rocker arms are unloaded on cylinder A1, the piston is in firing TDC.
  - If the rocker arms are loaded on cylinder A1, the piston is in overlap TDC.
2. Check valve clearance with cold engine:
  - Inlet valves (long rocker arm) = 0.2 mm
  - Exhaust valves (short rocker arm) = 0.5 mm
3. Check all valve clearances at two crankshaft positions (firing and overlap TDC for cylinder A1) as per diagram.
4. Use feeler gauge to determine the distance between valve bridge and rocker arm.
5. If the deviation from the reference value exceeds 0.1 mm, adjust valve clearance.

1					2				
A10			x	x	B10				
A9					B9				
A8			x	x	B8	x	x		
A7	x	x			B7				
A6					B6			x	x
A5	x	x	x	x	B5				
A4					B4	x	x	x	x
A3					B3			x	x
A2	x	x	x	x	B2				
A1					B1			x	x
KS					KS				

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## Adjusting valve clearance

1. Release locknut (1).
2. Insert feeler gauge between valve bridge and rocker arm.
3. Using Allen key, set adjusting screw (2) so that the specified valve clearance is provided.
4. Feeler gauge must just pass through the gap.
5. Tighten locknut (1) to 90 +9 Nm, holding adjusting screw (2) firm.
6. Replace or rectify adjusting screws and/or locknuts which do not move freely.
7. Check valve clearance.



## Final steps

1. Remove barring tool (→ Page 52).
2. Install cylinder head cover (→ Page 74).

### 7.5.3 Cylinder head cover – Removal and installation

#### Preconditions

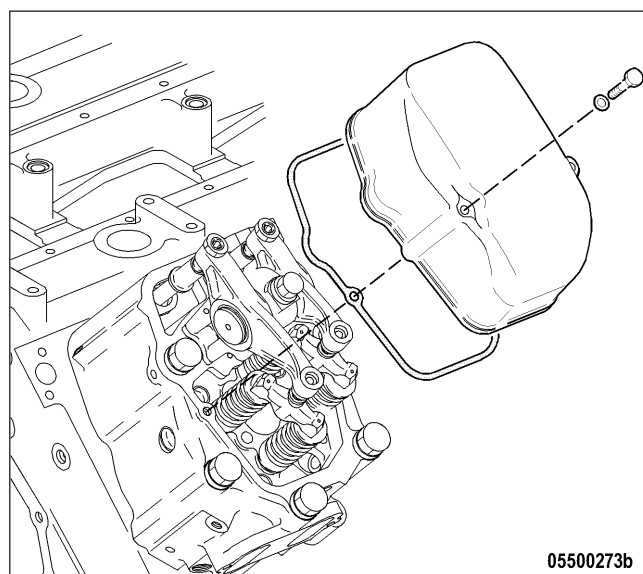
- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Gasket	(→ Spare Parts Catalog)	

#### Removing cylinder head cover

1. Clean very dirty cylinder head covers prior to removal.
2. Remove screws.
3. Remove cylinder head cover with gasket from cylinder head.



#### Installing cylinder head cover

1. Clean mating face.
2. Check condition of gasket, replace if necessary.
3. Place gasket and cylinder head cover on cylinder head.
4. Install cylinder head cover.

## 7.6 Injection Pump / HP Pump

### 7.6.1 HP pump - Filling with engine oil

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		

#### WARNING



Fuels are combustible.

#### Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

#### WARNING



Oils/oil vapors are combustible/explosive.

#### Risk of fire and explosion!

- Avoid open flames, electric sparks and ignition sources.
- Do not smoke.

#### NOTICE



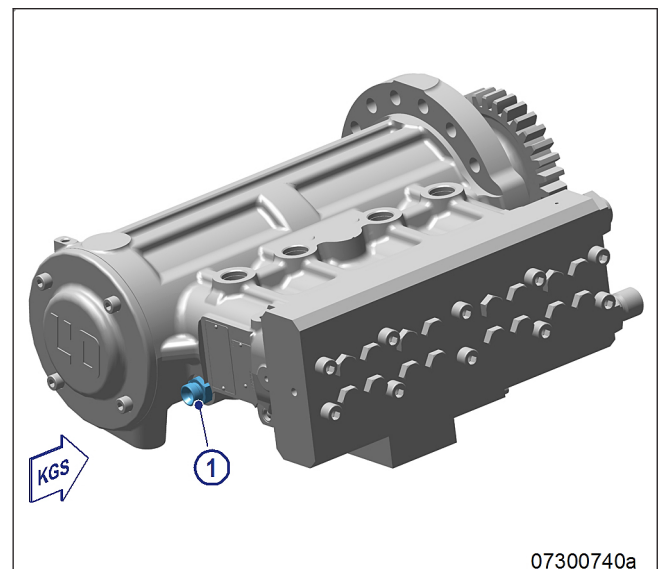
HP fuel pump not filled with engine oil.

#### Damage to components, major material damage!

- Ensure that th HP fuel pump is filled with engine oil before it is installed or put into operation.

#### Filling HP pump

1. Remove plug screw (1).
2. Use pump oiler to fill HP pump with engine oil until engine oil emerges.
3. Install plug screw (1).



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## 7.6.2 HP pump – Relief bore check

### DANGER



Rotating and moving engine parts.

**Risk of crushing, danger of parts of the body being caught or pulled in.**

- Only run the engine at low power. Keep away from the engine's danger zone.

### WARNING



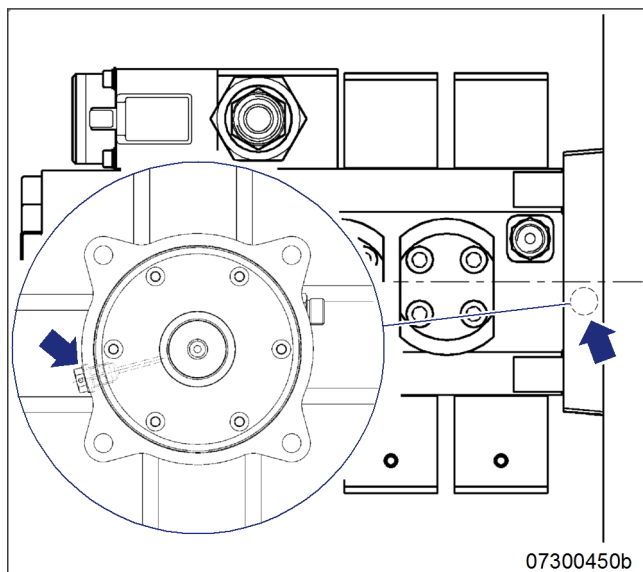
A high level of noise is produced when the engine is running.

**Risk of damage to hearing.**

- Wear ear defenders.

### HP pump – Relief bore check

1. Check relief bore for oil and fuel discharge by visual inspection.
2. If relief bore is contaminated, stop the engine, disable engine start, and clean relief bore.
3. Note the following in case of fluid discharge:
  - Heavy discharge means continuous discharge of fluids (leakage). Contact Service.
  - Minor discharge of fluids up to 10 drops per day is normal (moistening) and not considered a leakage.





## 7.7 Injection Valve / Injector

### 7.7.1 Injector – Replacement

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Injector	(→ Spare Parts Catalog)	

#### Replacing injector

- Remove injector and install new injector (→ Page 78).

## 7.7.2 Injector – Removal and installation

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Installation and removal tool for injector	F6790161	1
Milling cutter	F30452739	1
Slotted screwdriver	F30452578	1
Torque wrench, 4-20 Nm	F30044239	1
Torque wrench, 10-60 Nm	F30452769	1
Torque wrench, 60-320 Nm	F30452768	1
Assembly paste (Optimoly Paste White T)	40477	1
Grease (Kluthe Hakuform 30-10/emulsifier)	X00029933	1
Engine oil		

#### WARNING



Fuels are combustible.

#### **Risk of fire and explosion!**

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

#### NOTICE



Cable damage during operation.

#### **Fire hazard!**

- Twist the cables when attaching.
- Ensure that the cables do not touch any components.

#### NOTICE



Removal of all injectors.

#### **Damage to component!**

- Ensure that the high-pressure fuel accumulator is secured on the engine through two HP lines.

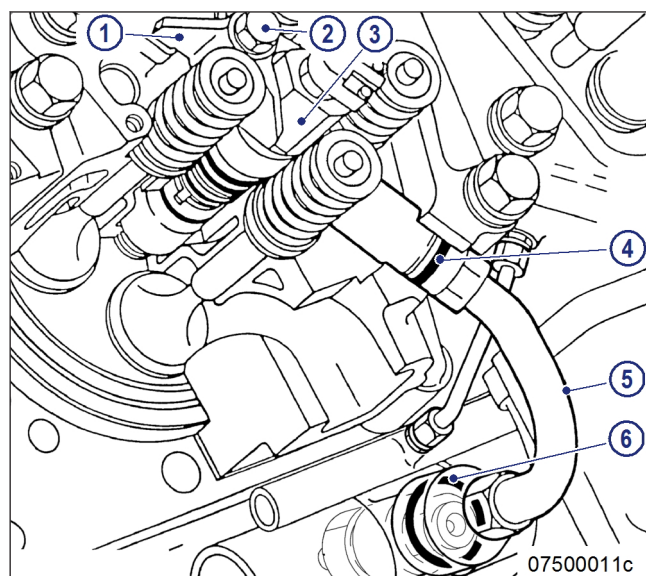
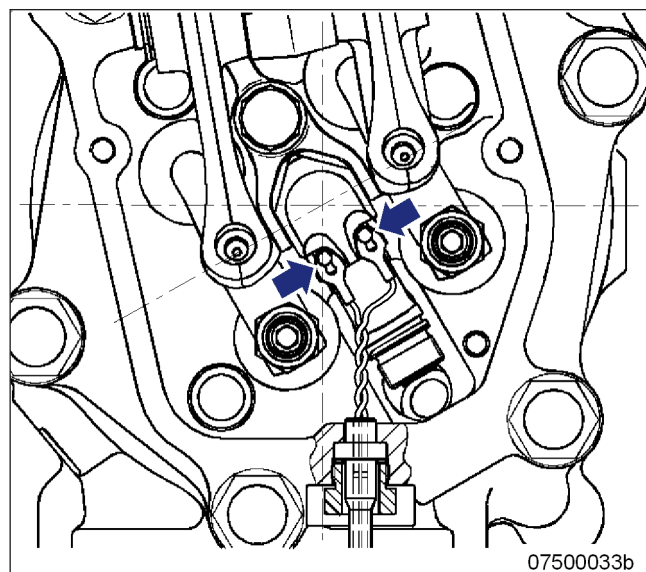
### Preparatory steps

1. Close off fuel supply to engine.
2. Remove cylinder head cover (→ Page 74).

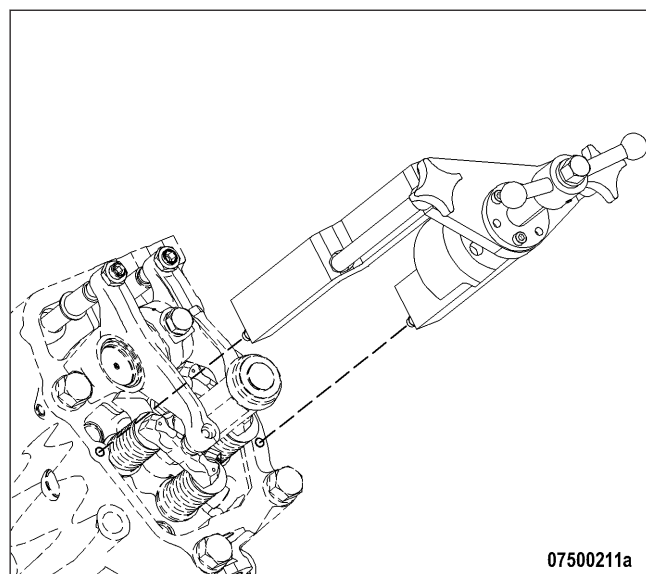
## Remove injector

Note: Always replace the first and last injectors of one engine side first. Replace the inner injectors only after the installation of the outer injectors on this engine side is completed.

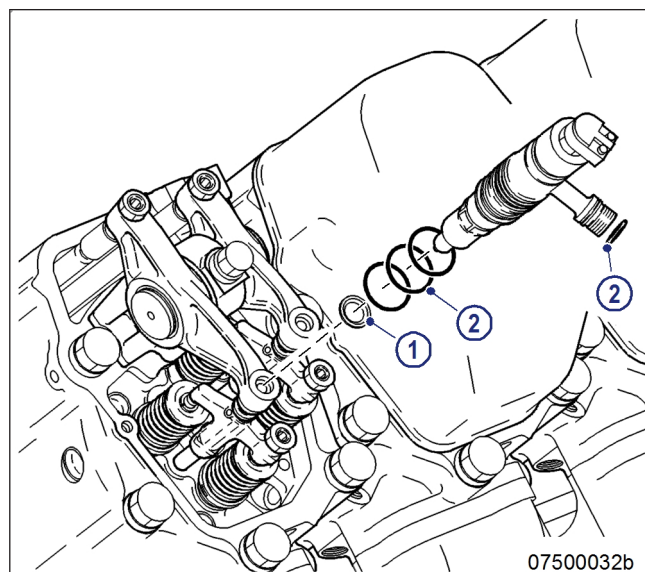
1. Release the cable terminal threaded connection (arrows) on the injector and remove cable terminals.
2. Remove screw (2) and take off hold-down clamp (1).
3. Remove high-pressure fuel line (5).



4. Install installation/removal device on the cylinder head.
5. Remove injector with installation/removal device.
6. Remove the installation/removal device.

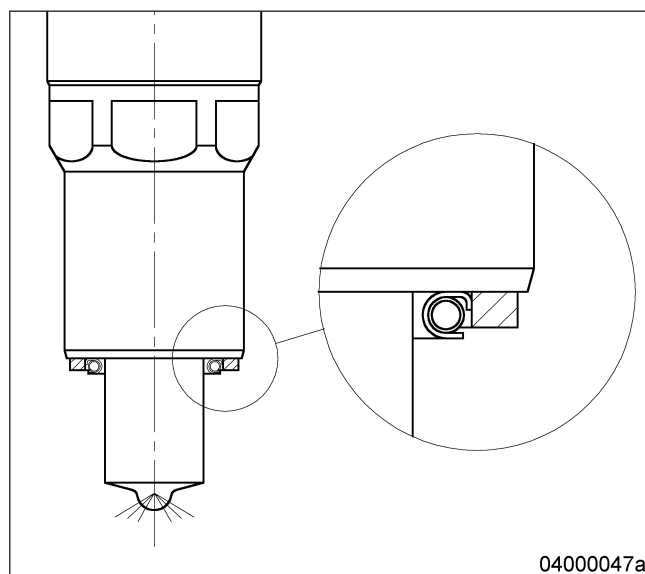


7. Remove sealing ring (1) from injector or use a self-made hook to take it out of the cylinder head.
8. Remove O-rings (2) from injector.
9. Cover all connections and installation bores, or seal with suitable plugs.

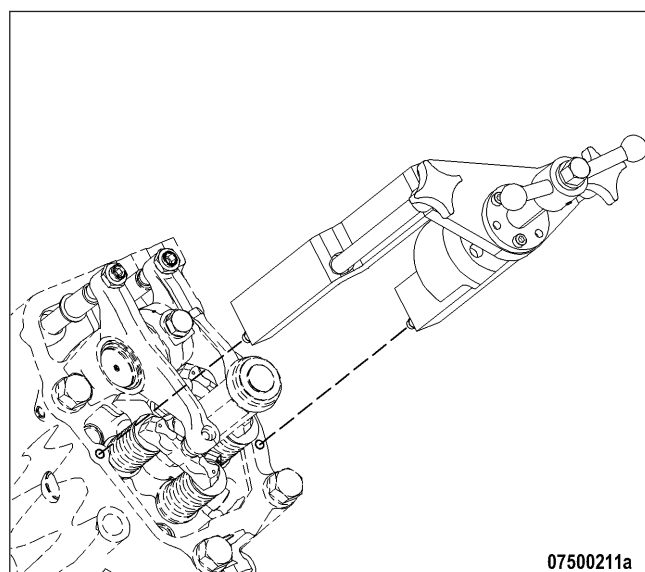


### Install injector

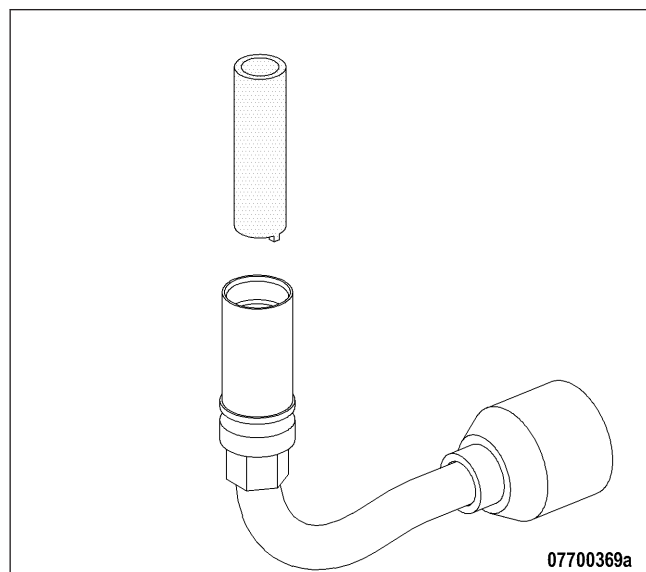
1. Prior to installation, remove all blanking plugs.
2. Coat injector with assembly paste in the area of the nozzle retaining nut.
3. Fit new O-rings on injector and coat with grease.
4. Fit new sealing ring with grease on injector, observe installation position of sealing ring.



5. Clean sealing face on cylinder head and protective sleeve with milling cutter.
6. Insert injector into cylinder head, making sure that the HP line connections are aligned correctly.
7. Push in the injector using the installation/removal device.
8. Remove the installation/removal device.



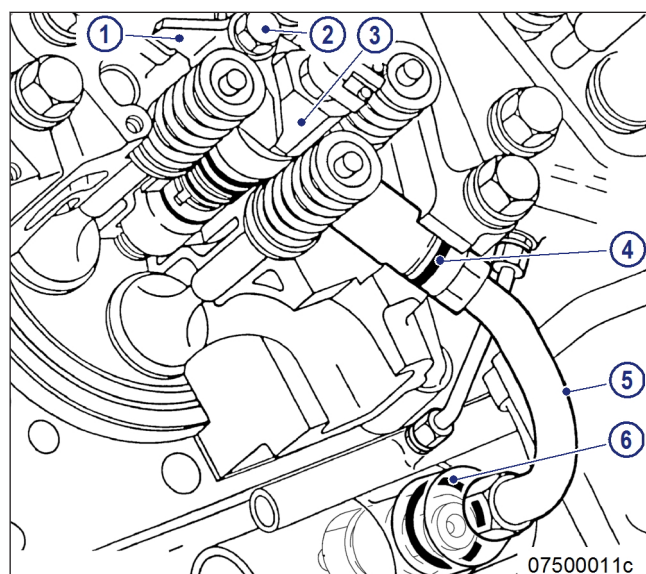
9. Use slotted screwdriver to check thrust ring at both line ends for secure seating.



10. Tighten loose thrust ring to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Thrust ring		Tightening torque		5 Nm to 10 Nm

11. Coat screw head mating face (2) and thread with engine oil.



12. Fit hold-down clamp (1) in correct position by hand. Tighten screw (2) with torque wrench to the specified initial tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M12	Preload torque	(Engine oil)	5 Nm to 10 Nm

13. Fit O-rings (4) and (6) on high-pressure fuel line (5) and coat with grease.

14. Tighten high-pressure fuel line (5) to the specified initial tightening torque.

Name	Size	Type	Lubricant	Value/Standard
HP line		Preload torque	(Engine oil)	5 Nm to 10 Nm

15. Tighten screw (2) to specified torque using a torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw	M12	Tightening torque		100 Nm + 10 Nm

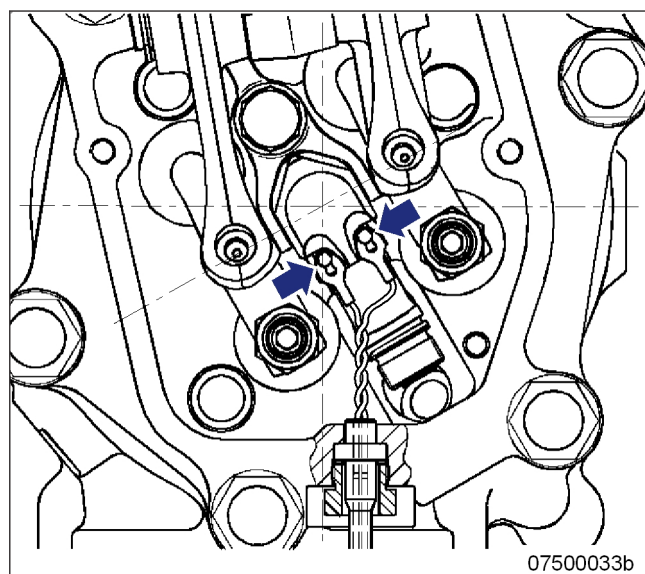
16. Tighten union nut of adapter (limiting valve) with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		140 Nm + 10 Nm

17. Tighten union nut of adapter (injector) with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Union nut		Tightening torque		120 Nm + 10 Nm

18. Twist cable several times.



19. Insert cable lugs (arrows) underneath the screws on the injector and tighten screws with torque wrench to the specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		1.5 Nm

## Final steps

1. Install cylinder head cover (→ Page 74).
2. Open up fuel supply to engine.

## 7.8 Fuel System

### 7.8.1 Fuel system - Venting

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		

#### WARNING



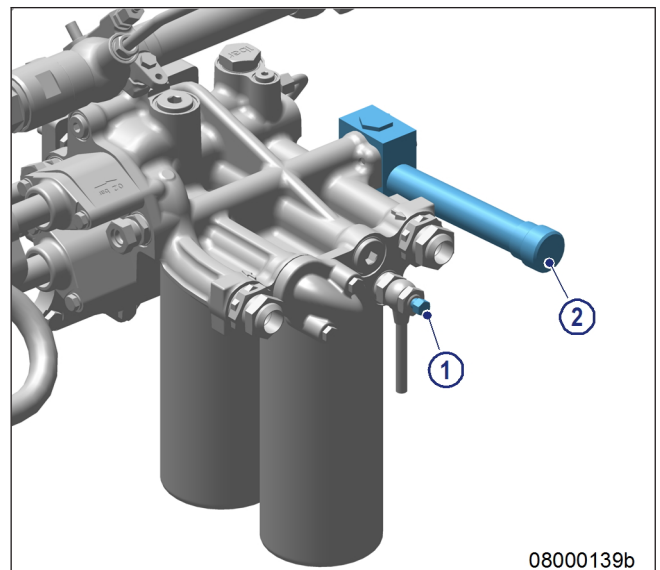
Fuels are combustible.

#### Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

#### Venting LP fuel system

1. Open vent plug (1).
2. Unlock fuel priming pump (2), screw out handle by turning it counterclockwise.
3. Operate the pump with the handle (2) until bubble-free fuel emerges from the vent plug (1).
4. Close vent plug (1).
5. Screw in handle by turning it clockwise.
6. Verify that fuel priming pump (2) is locked: Handle must be tightened.



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## 7.9 Fuel Filter

### 7.9.1 Fuel filter – Replacement

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Engine oil		
Easy-change filter	(→ Spare Parts Catalog)	

#### WARNING



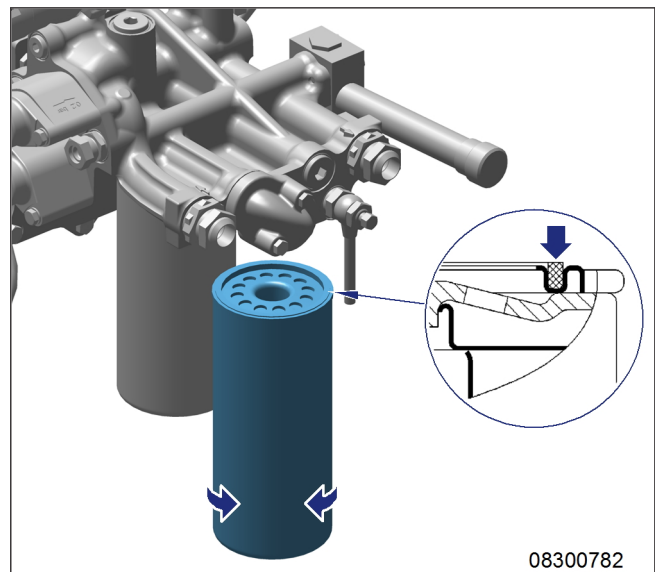
Fuels are combustible.

#### Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

#### Fuel filter – Replacement

1. Remove easy-change filter using filter wrench.
2. Clean sealing face on filter head.
3. Apply a thin coat of oil to the seal on the easy-change filter (arrowed).
4. Screw on the easy-change filter by hand until the seal is in contact and tighten hand-tight.
5. Replace the other easy-change filters in the same way.
6. Vent fuel system (→ Page 83).





## 7.9.2 Draining fuel prefilter

### Preconditions

- ☑ Engine shut down and secured against being restarted.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		

#### WARNING



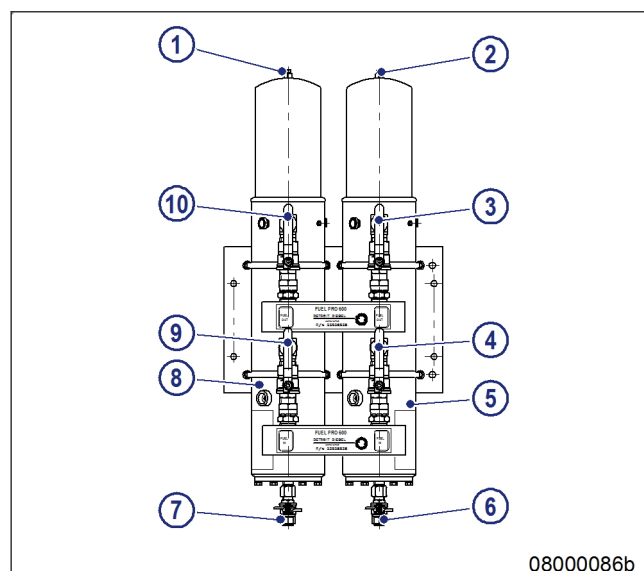
Fuels are combustible.

#### Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

### Draining fuel prefilter

1. Shut off the filter unit (5/8) to be changed at valves (3) and (4) or (9) and (10).
2. Open bleed screw (1) or (2) on filter to be drained.
3. Open drain valve (6) or (7).
4. Drain water and dirt from the filter until clean fuel emerges.
5. Close drain valve (6) or (7).
6. Open fuel return line (3) or (10).
7. Open fuel inlet (4) or (9).
8. Close bleed screw (1) or (2) on filter to be drained when clean fuel emerges.



### 7.9.3 Edge-type fuel filter – Draining

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Diesel fuel		
Sealing ring	(→ Spare Parts Catalog)	

#### WARNING



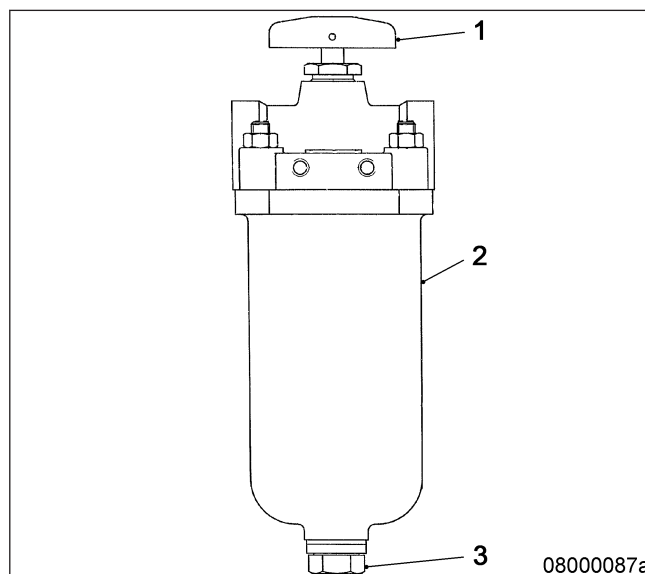
Fuels are combustible.

#### Risk of fire and explosion!

- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

#### Edge-type fuel filter – Draining

1. Rotate edge-type filter (2) with handle (1) clockwise several times.
2. Do not apply force when rotating handle.
3. Close fuel supply.
4. Remove drain plug (3) from edge-type filter (2).
5. Drain water and contaminants through drain plug opening (3) until pure fuel emerges from filter.
6. Fit drain plug (3) with new sealing ring and screw in.
7. Open fuel supply.



## 7.9.4 Auxiliary fuel filter – Replacement

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Engine oil		
Easy-change filter	(→ Spare Parts Catalog)	2

#### WARNING



Fuels are flammable and explosive.

#### **Danger to life! Risk of burns!**

- Avoid naked flames, electrical sparks and ignition sources.
- Do not smoke.
- Wear protective clothing, protective gloves, and goggles / safety mask.

#### NOTICE



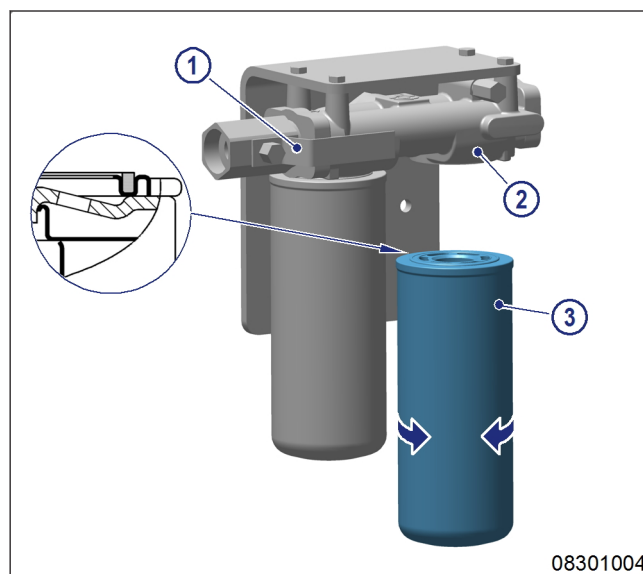
Fuels are flammable and explosive.

#### **Risk of severe component damage and other severe damage!**

- Avoid naked flames, electrical sparks and ignition sources.
- Do not smoke.

### Replacing auxiliary fuel filter

1. Provide suitable container to collect escaping fuel.
2. Close fuel feed with stopcock (1).
3. Remove easy-change filter (3) with filter wrench.
4. Clean sealing surface on filter head (2).
5. Coat gasket on easy-change filter (3) slightly with engine oil (arrow).
6. Screw on easy-change filter (3) by hand until the seal makes contact with the filter head and tighten manually.
7. Replace further easy-change filters in the same way.
8. Open stopcock (1).
9. Vent fuel system (→ Page 83).



## 7.10 Charge-Air Cooling

### 7.10.1 Intercooler – Check water drain for coolant leakage and absence of restrictions

#### DANGER



Rotating and moving engine parts.

**Risk of crushing, danger of parts of the body being caught or pulled in.**

- Only run the engine at low power. Keep away from the engine's danger zone.

#### WARNING



A high level of noise is produced when the engine is running.

**Risk of damage to hearing.**

- Wear ear defenders.

#### WARNING



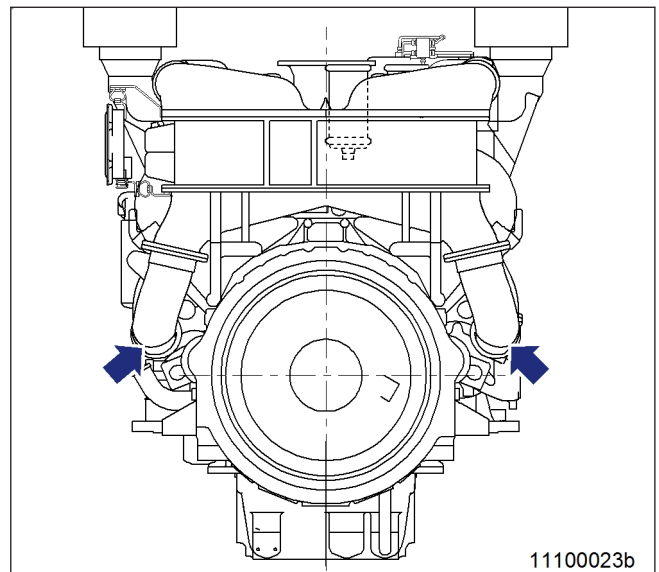
Compressed air gun ejects a jet of pressurized air.

**Risk of injury to eyes and damage to hearing, risk of rupturing internal organs.**

- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

#### Intercooler – Check water drain for coolant leakage and absence of restrictions

1. With the engine running check the drain bore(s) on the right and left of the engine for emerging air (at driving end). If no air escapes:
  - Clean drain bore(s)
  - Blow out with compressed air
2. If a large amount of coolant is continuously discharged, the intercooler is leaking. Contact Service.



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#### Emergency measures prior to engine start with a leaking intercooler

1. Remove injectors (→ Page 78).
2. Bar engine manually (→ Page 52).
3. Bar engine with starting system to blow out combustion chambers (→ Page 54).
4. Install injectors (→ Page 78).

## 7.11 Air Filter

### 7.11.1 Air filter element and dust bowl (optional) - Cleaning

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Gasket	(→ Spare Parts Catalog)	

#### WARNING



Compressed air gun ejects a jet of pressurized air.

**Risk of injury to eyes and damage to hearing, risk of rupturing internal organs.**

- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

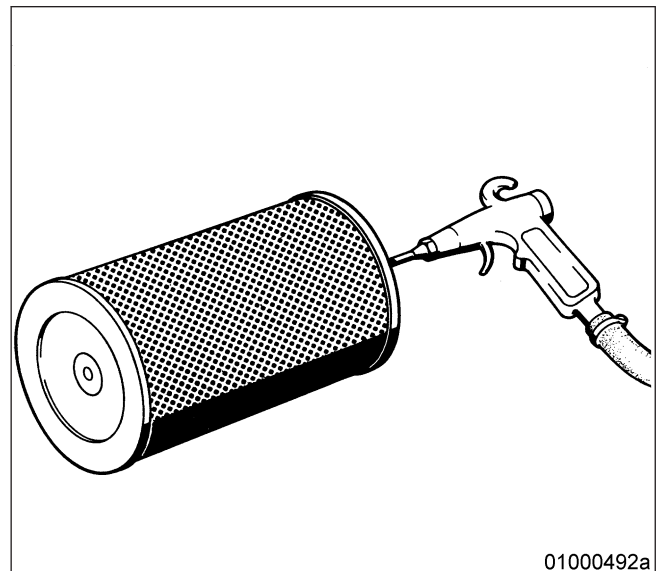
#### Clean air filter element

Note: Clean paper filter element dry only.

1. Open air filter and remove filter element (→ Page 91).
2. Check gasket for damage and cleanness, replace if necessary.
3. Clean all sealing and contact surfaces.

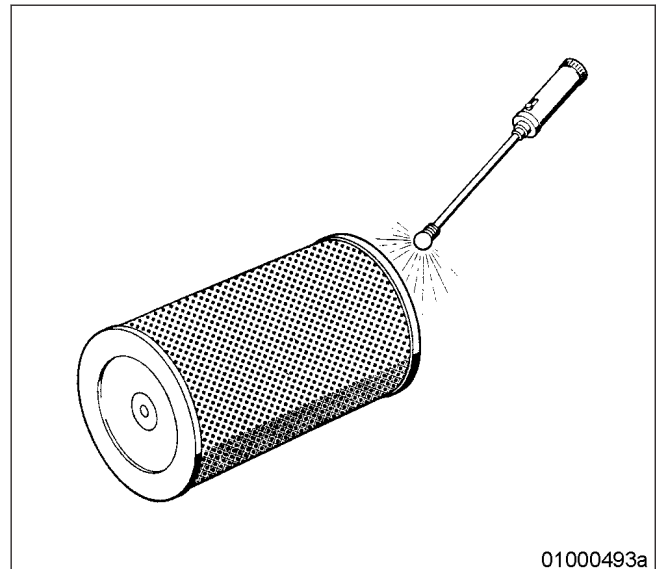
Note: Debris particles must not enter the intake system.

4. Clean dust bowl (if available).
5. Blow out filter element with compressed air (max. 3 bar) from the inside out, until no more dust is blown out.
6. Fit new filter element if old one is heavily contaminated or damaged (→ Page 90).



#### Visual inspection

1. Use inspection lamp to check cleaned filter element for damage.
2. Fit new filter element if old one is damaged (→ Page 90).



### 7.11.2 Air filter – Replacement

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Air filter	(→ Spare Parts Catalog)	

#### Air filter – Replacement

1. Remove air filter and install new one (→ Page 91).
2. Reset signal ring of service indicator (→ Page 92).

7.11.3 Air filter element – Removal and installation (optional)

Preconditions

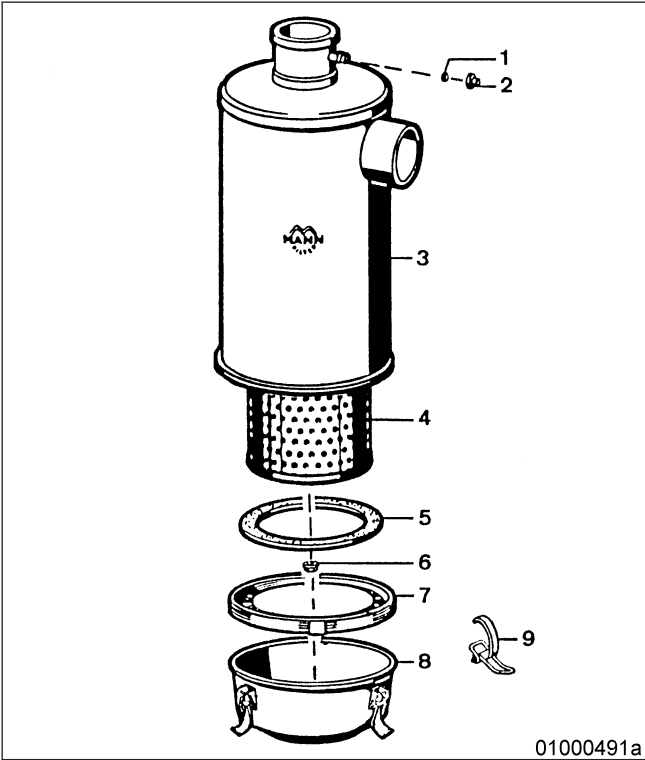
☑ Engine is stopped and starting disabled.

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Gasket	(→ Spare Parts Catalog)	

Removing and installing air filter element

1. Release latches (9).
2. Remove dust bowl (8) and partition (7).
3. Remove collar nut (6).
4. Screw off air filter element (4).
5. Clean housing (3) and dust bowl (8).
6. Check seal (5) for damage and cleanness, replace if necessary.
7. Clean all sealing and contact surfaces.
8. Fit partition (7) and dust bowl (8) according to marking.
9. Secure dust bowl (8) with latches (9).



#### 7.11.4 Service indicator – Signal ring position check (optional)

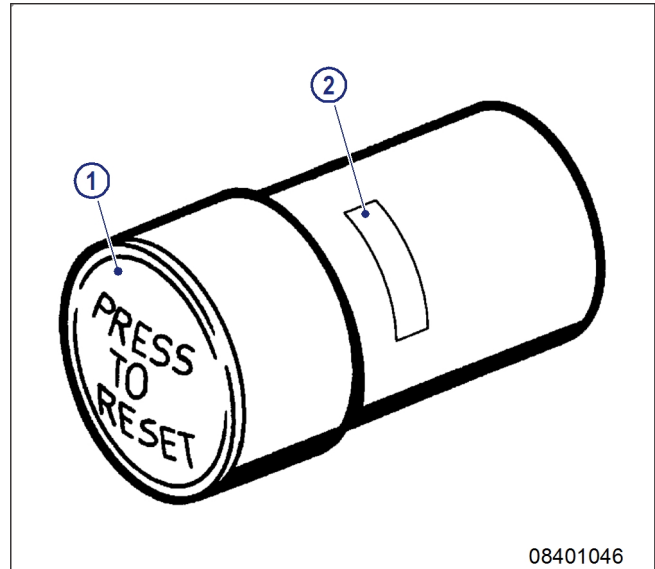
##### Preconditions

- ☑ Engine is stopped and starting disabled.

##### Checking signal ring position

1. If the signal ring is completely visible in the control window (2), replace air filter (→ Page 90).
2. After installation of new filter, press reset button (1).

Result: Engaged piston with signal ring moves back to initial position.





## 7.12 Starting Equipment

### 7.12.1 Starter - Condition check

#### **Preconditions**

- ☒ Engine is stopped and starting disabled.

#### **Checking starter condition**

1. Check securing screws of starter for secure seating and tighten if required.
2. Check wiring (→ Page 128).

## 7.13 Lube Oil System, Lube Oil Circuit

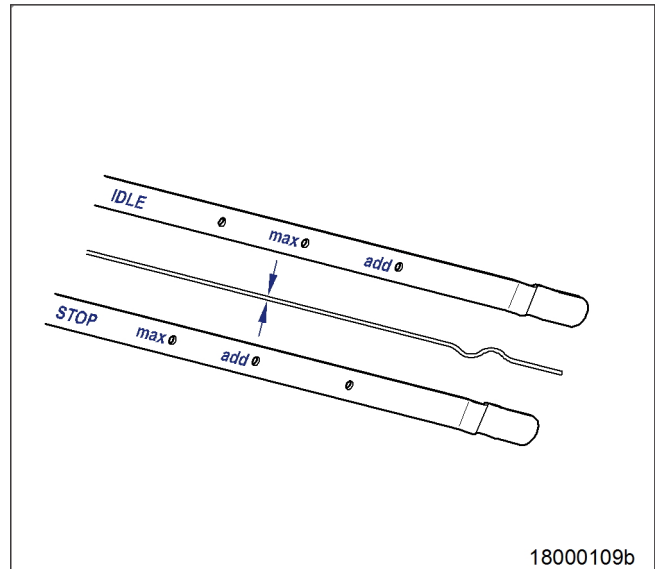
### 7.13.1 Checking engine oil level

#### Checking oil level before starting engine

1. Withdraw oil dipstick from guide tube and wipe it clean.
2. Insert dipstick into guide tube and push fully home, withdraw after approx. 10 seconds. Check oil level on oil dipstick side marked "5 Min. after Stop".

Note: After extended out-of-service periods, the oil level may be up to 2 cm above the "max." mark. This might be caused by engine oil flowing from oil filter and heat exchanger back into the oil pan.

3. The oil level must reach the "max." mark or exceed it by up to 2 cm.
4. If necessary, top up to "max." mark (→ Page 95).
5. Insert oil dipstick into guide tube and push fully home.



#### Checking engine oil level with the engine running

1. After the engine has run for approx. 10 minutes at a constant speed of 900 rpm, withdraw oil dipstick from guide tube and wipe it.
2. Insert dipstick into guide tube and push fully home, withdraw after approx. 10 seconds. Check oil level on the dipstick side marked "IDLE".
3. Oil level must not be lower than the "add" mark.
4. If necessary, top up to "max." mark (→ Page 95).

#### Checking oil level after engine has been shut down

1. 5 minutes after stopping the engine, remove oil dipstick from the guide tube and wipe it.
2. Insert dipstick into guide tube and push fully home, withdraw after approx. 10 seconds. Check oil level on oil dipstick side marked "5 Min. after Stop".
3. Oil level must be between "add." and "max." marks.
4. If necessary, top up to "max." mark (→ Page 95).
5. Insert oil dipstick into guide tube and push fully home.

## 7.13.2 Engine oil – Change

### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Engine is at operating temperature.
- ☑ MTU Fluids and Lubricants Specification (A001061/..) is available.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine oil		
Sealing ring	(→ Spare Parts Catalog)	

#### WARNING



Hot oil.

Oil can contain combustion residues which are harmful to health.

#### **Risk of injury and poisoning!**

- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

### Procedure without pump: Draining oil at drain plug on oil pan

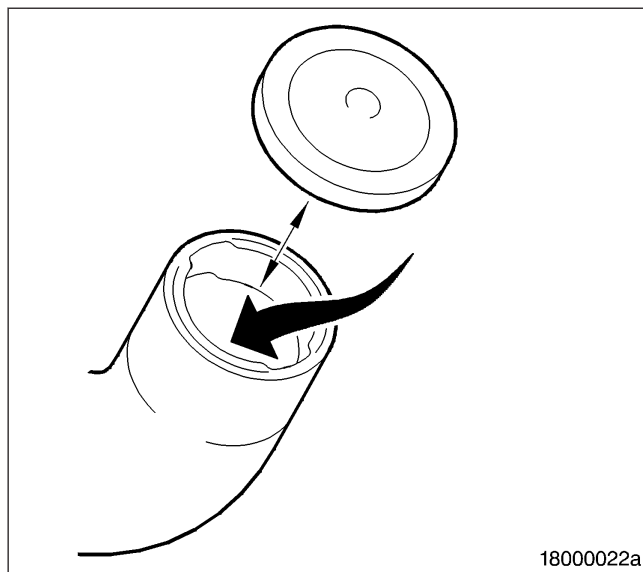
1. Provide a suitable container in which to collect the oil.
2. Remove drain plug and drain oil.
3. Install drain plug with new sealing ring.

### Procedure with pump: Oil extraction

1. Provide a suitable container in which to collect the oil.
2. Extract all oil from oil pan using the pump.

### Filling with new oil

1. Open cover of filler neck.
2. Pour oil in at filler neck up to "max." mark at oil dipstick.
3. Close cover of filler neck.
4. Check engine oil level (→ Page 94).
5. After oil change, bar engine with starting system (→ Page 54).



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## 7.14 Oil Filtration / Cooling

### 7.14.1 Automatic oil filter – Oil filter candles replacement

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Grease (Kluthe Hakuform 30-10/Emulgier)	X00029933	1
Engine oil		
O-ring	(→ Spare Parts Catalog)	
Oil filter candles	(→ Spare Parts Catalog)	

#### WARNING



- Hot oil.  
Oil can contain combustion residues which are harmful to health.  
**Risk of injury and poisoning!**
- Wear protective clothing, gloves, and goggles / safety mask.
  - Avoid contact with skin.
  - Do not inhale oil vapor.

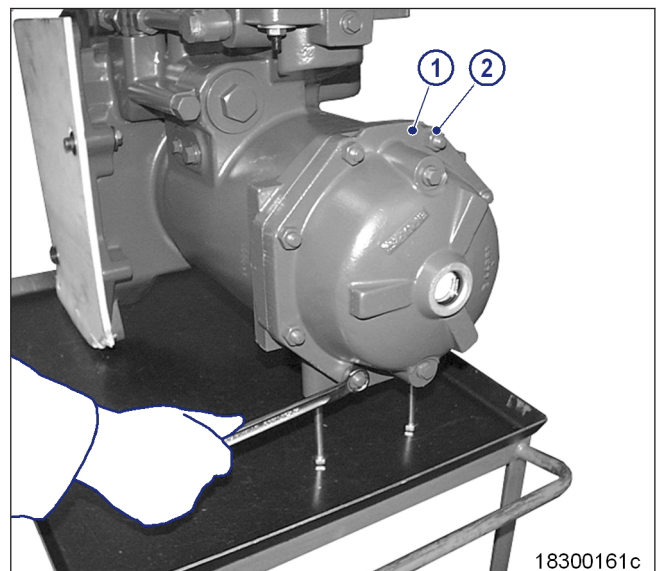
#### NOTICE



- Contamination of components.  
**Damage to component!**
- Observe manufacturer's instructions.
  - Check components for special cleanliness.

#### Removing oil filter candles

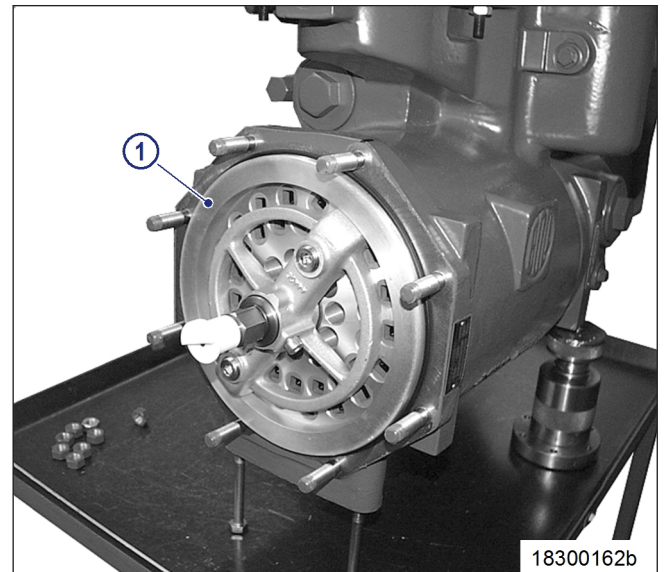
1. Remove nuts (2) from oil filter cover (1).
2. Remove oil filter cover (1).



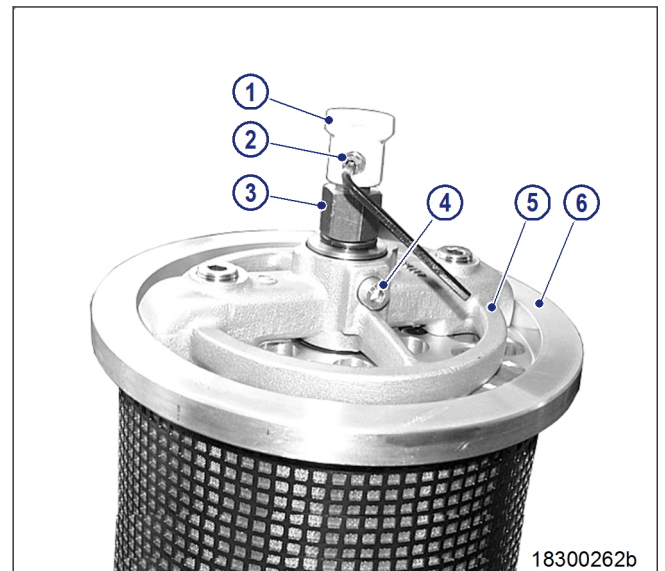
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TIM-ID: 0000006401 - 006

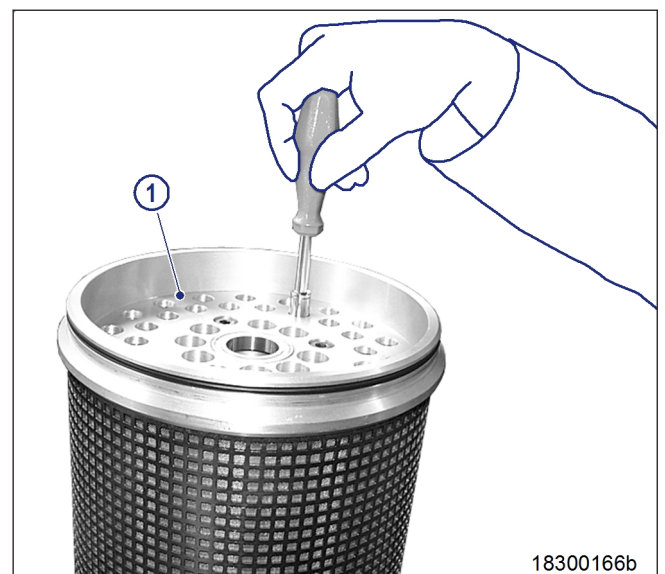
3. Withdraw oil filter element (1).
4. Remove O-ring.



5. Remove screw (2).
6. Withdraw plastic spinner (1) with spring.
7. Remove nut (3).
8. Take off spring washer and washer.
9. Remove screw (4).
10. Remove flushing arm (5) from screen plate (6).



11. Turn filter element by 180° and use appropriate tool to push out filter candles (1).
12. Turn filter insert by 180° and insert new filter candles (1) with chamfer facing downwards.



## Installing oil filter candles

1. For installation follow reverse sequence of working steps.
2. Additionally, the following instructions are to be observed:
  - Replace all sealing elements.
  - Coat O-rings with grease.
  - Insert O-rings in grooves.
  - Observe position of cylinder screw to elongated hole on shaft.

## 7.14.2 Oil indicator filter – Cleaning and check

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cleaner (Snow-White 11-0)	40460	1
Cleaner (Hakupur 312)	30390	1
Engine oil		
Strainer	(→ Spare Parts Catalog)	
Square-section ring	(→ Spare Parts Catalog)	
O-ring	(→ Spare Parts Catalog)	

#### WARNING



- Hot oil.  
Oil can contain combustion residues which are harmful to health.  
**Risk of injury and poisoning!**
- Wear protective clothing, gloves, and goggles / safety mask.
  - Avoid contact with skin.
  - Do not inhale oil vapor.

#### WARNING



- Compressed air gun ejects a jet of pressurized air.  
**Risk of injury to eyes and damage to hearing, risk of rupturing internal organs.**
- Never direct air jet at people.
  - Always wear safety goggles/face mask and ear defenders.

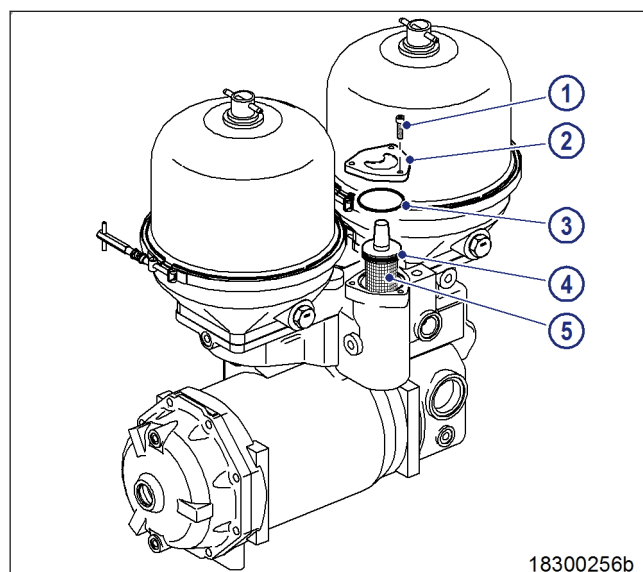
#### NOTICE



- Inappropriate cleaning tool.  
**Risk of damage to component!**
- Observe manufacturer's instructions.
  - Use appropriate cleaning tool.

### Removing strainer

1. Clean oil indicator filter before disassembling it.
2. Remove screws (1).
3. Take off cover (2) with O-ring (3).
4. Take strainer (5) from filter housing.



## Checking strainer

Item	Findings	Measure
Strainer	Metallic residues	<ul style="list-style-type: none"><li>• Clean</li><li>• Monitor engine operation</li><li>• Check strainer daily</li><li>• Contact Service</li></ul>
Strainer	Damaged	Fit new part
Square-section ring	Damaged	Fit new part
O-ring	Damaged	Fit new part

## Cleaning strainer

1. Wash strainer (5) with cleaner.
2. Remove stubborn deposits with soft brush.
3. Blow out strainer (5) with compressed air from inside.

## Installing strainer

1. Coat square-section ring (4) on strainer (5) with engine oil and install strainer (5).
2. Coat O-ring (3) with engine oil and fit in filter housing.
3. Fit cover (2) and secure with screws (1) and washers.



### 7.14.3 Cleaning centrifugal oil filter and replacing filter sleeve

#### Preconditions

- ☒ Engine shut down and secured against being restarted.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Torque wrench, 6 to 50 Nm	F30027336	1
Cold cleaner (Hakutex 60)	X00056750	1
Filter sleeve	(→ Spare Parts Catalog)	
Sealing ring	(→ Spare Parts Catalog)	

#### WARNING



- Hot oil.  
Oil can contain combustion residues which are harmful to health.  
**Risk of injury and poisoning!**
- Wear protective clothing, gloves, and goggles / safety mask.
  - Avoid contact with skin.
  - Do not inhale oil vapor.

#### WARNING



- Compressed air gun ejects a jet of pressurized air.  
**Risk of injury to eyes and damage to hearing, risk of rupturing internal organs.**
- Never direct air jet at people.
  - Always wear safety goggles/face mask and ear defenders.

## Cleaning centrifugal oil filter and replacing filter sleeve

1. Remove clamp (14).
2. Undo cover screw (2) and take off cover (1).
3. Carefully lift rotor (11), allow oil to drain and remove from housing.
4. Holding the rotor (11) firmly, release rotor cover nut (3).
5. Take off rotor cover (4).
6. Remove filter sleeve (6).
7. Measure thickness of oil residues on filter sleeve (6).

Result: If the oil residues exceed the maximum layer thickness of 45 mm, shorten the service interval.

8. Dismantle rotor tube (7), conical disk (8) and rotor base (10).
9. Wash rotor cover (4), rotor tube (7), conical disk (8) and rotor base (10) with cold cleaner.
10. Blow out with compressed air.
11. Check sealing ring (9), fit new one if necessary.
12. Assemble rotor tube (7), conical disk (8) and rotor base (10) together with sealing ring (9).
13. Insert new filter sleeve (6) in rotor tube (7) with the smooth paper surface facing the wall.
14. Check sealing ring (5), fit new one if necessary.
15. Mount rotor cover (4) and sealing ring (5).
16. Tighten rotor cover nut (3) to the specified torque using torque wrench.

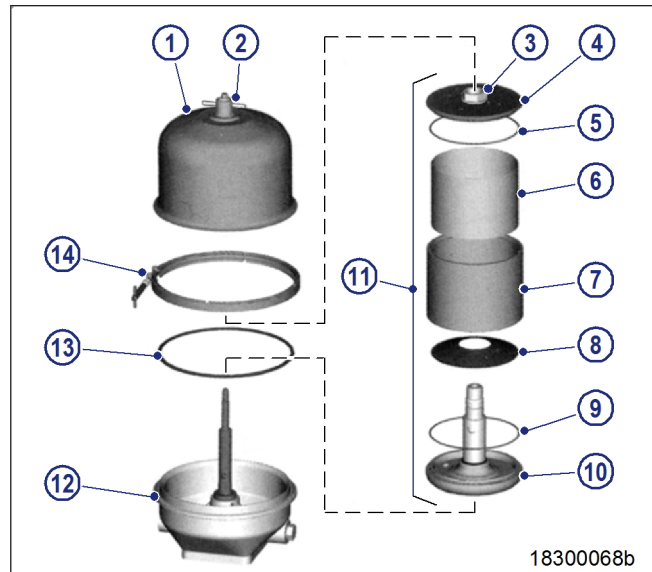
Name	Size	Type	Lubricant	Value/Standard
Nut		Tightening torque		35 Nm to 45 Nm

17. Place rotor (11) in housing (12) and check for ease of movement.
18. Check sealing ring (13), fit new one if necessary.
19. Fit sealing ring (13) on housing (12).
20. Fit cover (1).
21. Tighten cover screw (2) by hand.
22. Fit clamp (14) and tighten to the specified torque using torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Clamp		Tightening torque		8 Nm to 10 Nm

23. Tighten cover screw (2) to the specified torque using torque wrench.

Name	Size	Type	Lubricant	Value/Standard
Screw		Tightening torque		5 Nm to 7 Nm



## 7.15 Coolant Circuit, General, High-Temperature Circuit

### 7.15.1 Engine coolant – Level check

#### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

#### WARNING



Coolant is hot and under pressure.

#### Risk of injury and scalding!

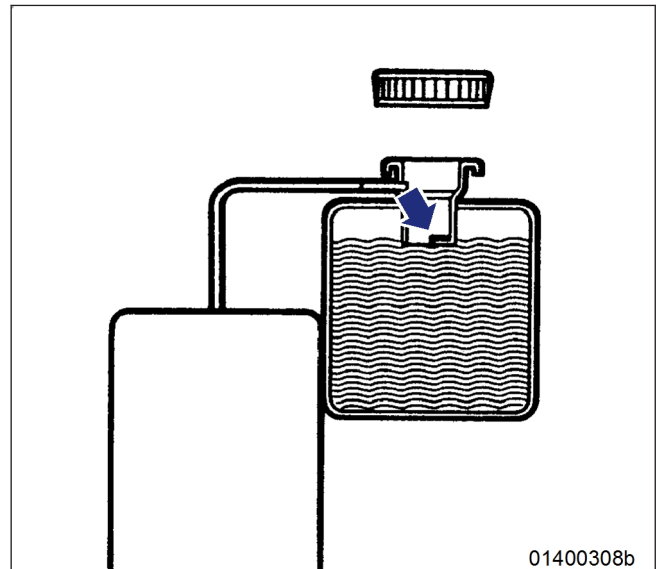
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

#### Checking engine coolant level at filler neck:

1. Turn breather valve on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check engine coolant level (coolant must be visible at the bottom edge of the filler neck's cast eye).

#### Checking engine coolant level at remote cooler:

1. Check engine coolant level (coolant must be visible at marker plate).
2. Top up engine coolant if necessary (→ Page 106).
3. Check and clean breather valve.
4. Place breather valve on filler neck and close.



#### Checking engine coolant level via level sensor:

1. Switch on engine control system and check readings on the display.
2. Top up engine coolant if necessary (→ Page 106).

## 7.15.2 Engine coolant – Change

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

### Engine coolant change

1. Drain engine coolant (→ Page 105).
2. Fill with engine coolant (→ Page 106).

### 7.15.3 Engine coolant – Draining

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### WARNING



Coolant is hot and under pressure.

#### **Risk of injury and scalding!**

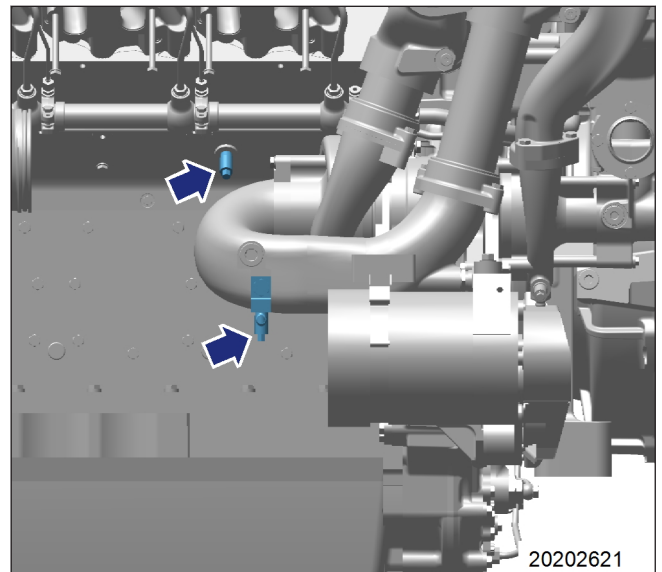
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

#### Preparatory steps

1. Provide a suitable receptacle to catch the coolant.
2. Switch off preheating unit.

#### Engine coolant – Draining

1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Draw off separated corrosion inhibitor oil in expansion tank through the filler neck.
4. Open drain valves and/or drain plugs and drain coolant at the following points:
  - at HT coolant pump elbow
  - on crankcase, left and right sides.
  - at preheating unit
5. Close all open drain points.
6. Position breather valve on filler neck and close.



## 7.15.4 Engine coolant – Filling

### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Engine coolant		

#### WARNING



Coolant is hot and under pressure.

#### **Risk of injury and scalding!**

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

#### NOTICE



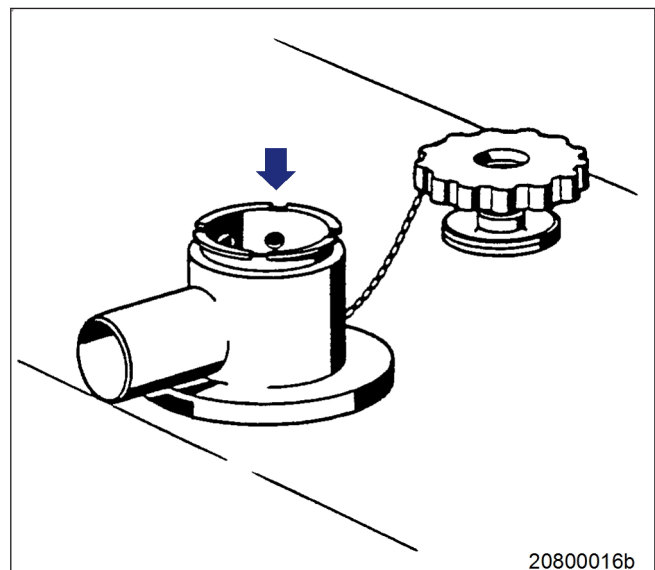
Cold coolant in hot engine can cause thermal stress.

#### **Possible formation of cracks in the engine!**

- Fill / top up coolant only into cold engine.

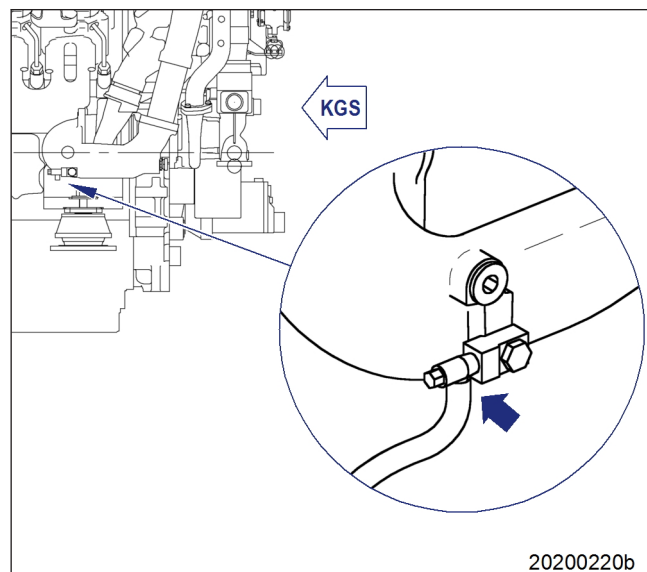
### Preparatory steps

1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.



## Filling with coolant using a pump

1. Connect appropriate pump with hose to drain valve.
2. Open drain valve and pump coolant into engine at 0.5 bar minimum.
3. Fill expansion tank until overflow edge is reached.
4. Close drain valve.
5. Check proper condition of breather valve and clean sealing faces if required.
6. Place breather valve on filler neck and close.
7. Start engine (→ Page 32).
8. After 10 seconds of running the engine without load, shut down the engine (→ Page 34).
9. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
10. Continue to turn breather valve counterclockwise and remove.
11. Check coolant level (→ Page 103) and top up engine coolant as required:
  - a) Fill in coolant in expansion tank until the coolant level at top edge of filler neck remains constant.
  - b) Place breather valve on filler neck and close.
  - c) Repeat the steps from "Start engine" (→ Step 7) until coolant is no longer needed to be topped up.
  - d) Disconnect pump and hose.



## Filling with coolant through filler neck

1. Alternatively: Fill in coolant in expansion tank via filler neck until coolant level at top edge of filler neck remains constant.
2. Check proper condition of breather valve and clean sealing faces if required.
3. Set breather valve onto filler neck and turn until the first stop.
4. Start engine (→ Page 32).
5. After 10 seconds of running the engine without load, shut down the engine (→ Page 34).
6. Turn breather valve counterclockwise and remove.
7. Check coolant level (→ Page 103) and top up engine coolant as required:
  - a) Repeat the steps from "Start engine" (→ Step 4) until coolant is no longer needed to be topped up.
  - b) Check proper condition of breather valve and clean sealing faces if required.
  - c) Place breather valve on filler neck and close.

## Final steps

1. Start the engine and run it without load for some minutes.
2. Check coolant level (→ Page 103) and top up engine coolant as required.

### 7.15.5 Engine coolant pump – Checking pressure relief port

#### DANGER



Rotating and moving engine parts.

**Risk of crushing, danger of parts of the body being caught or pulled in.**

- Only run the engine at low power. Keep away from the engine's danger zone.

#### WARNING



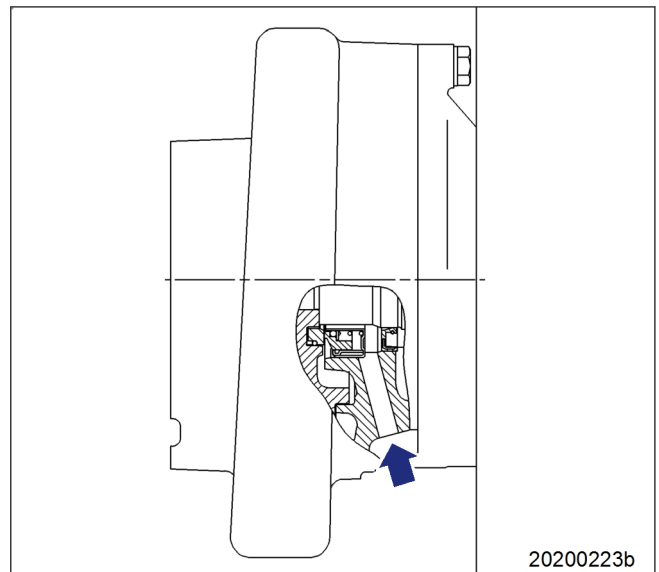
A high level of noise is produced when the engine is running.

**Risk of damage to hearing.**

- Wear ear defenders.

#### Engine coolant pump – Checking pressure relief port

1. Check pressure relief port for oil and coolant discharge.
2. Shut down engine (→ Page 34) and secure against being restarted, observe general “Maintenance and Repair” safety instructions.
3. Clean the pressure relief port with a wire if it is dirty.
  - Permissible coolant discharge rate: up to 10 drops per hour.
  - Permissible oil discharge rate: up to 5 drops/hour.
4. If discharge exceeds the specified limits: Contact Service.





## 7.15.6 Engine coolant – Sample extraction and analysis

### Preconditions

- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
MTU test kit	5605892099/00	1

#### DANGER



Rotating and moving engine parts.

**Risk of crushing, danger of parts of the body being caught or pulled in.**

- Only run the engine at low power. Keep away from the engine's danger zone.

#### WARNING



Coolant is hot and under pressure.

**Risk of injury and scalding!**

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

#### WARNING



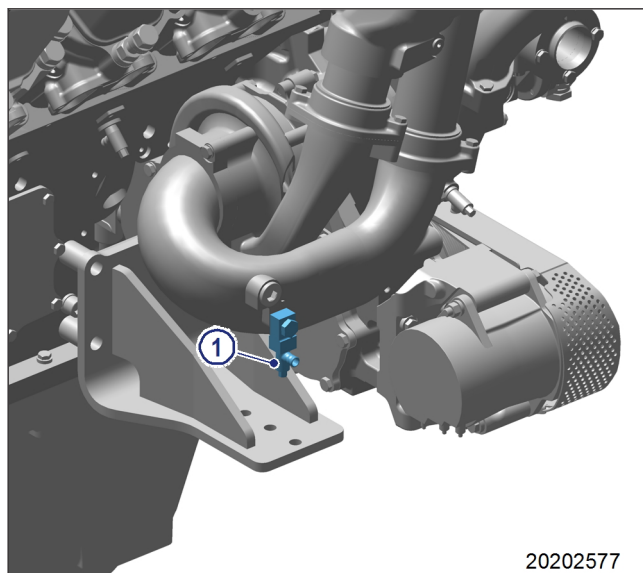
A high level of noise is produced when the engine is running.

**Risk of damage to hearing.**

- Wear ear defenders.

### Engine coolant – Sample extraction and analysis

1. With the engine running, open drain valve (1).
2. Flush sample-extraction point by draining approx. 1 liter coolant.
3. Drain approx. 1 liter coolant into a clean container.
4. Close drain valve (1).
5. Using the equipment and chemicals in the MTU test kit, examine coolant for:
  - Antifreeze concentration
  - Corrosion inhibitor concentration
  - pH value.
6. For engine coolant changing intervals (→ MTU Fluids and Lubricants Specifications (A001061/..)).



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## 7.15.7 Engine coolant filter – Replacement

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Filter wrench	F30379104	1
Engine oil		
Coolant filter	(→ Spare Parts Catalog)	

#### WARNING



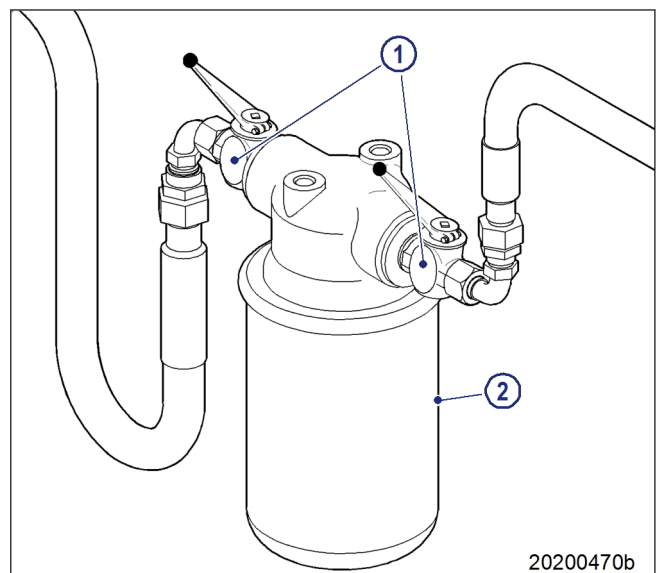
Coolant is hot and under pressure.

#### Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

### Engine coolant filter – Replacement

1. Close shutoff cocks (1).
2. Remove engine coolant filter (2) with filter wrench.
3. Clean the sealing surface on the connecting piece.
4. Coat gasket on new engine coolant filter with engine oil.
5. Screw on engine coolant filter and tighten hand-tight.
6. Open shutoff cocks (1).



## 7.16 Low-Temperature Circuit

### 7.16.1 Charge-air coolant - Level check

#### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

#### WARNING



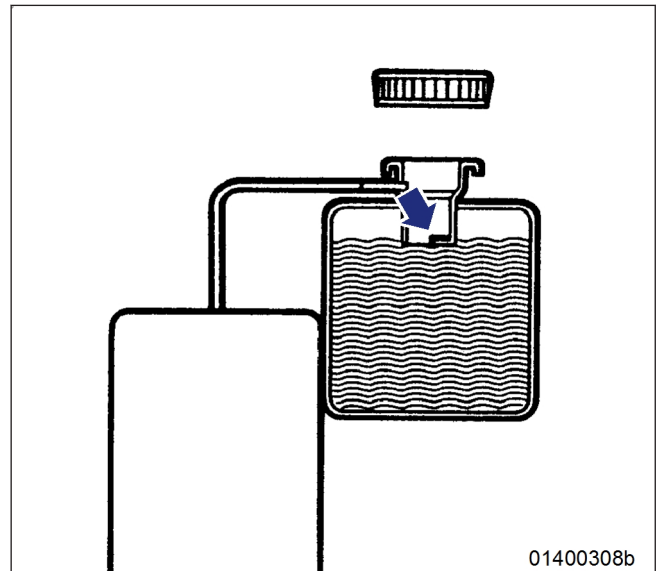
Coolant is hot and under pressure.

#### Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

#### Checking charge-air coolant level at filler neck:

1. Turn breather valve on coolant expansion tank counterclockwise to the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Check coolant level (coolant must be visible at marking plate).
4. Top up coolant if necessary (→ Page 114).
5. Check proper condition of breather valve, clean sealing faces if required.
6. Fit breather valve and close it.



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#### Checking charge-air coolant level by means of level sensor:

1. Switch on engine control system and check display (coolant level is automatically monitored by engine control system).
2. Top up coolant if necessary (→ Page 114).

## 7.16.2 Charge-air coolant – Change

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Coolant		

### Charge-air coolant – Change

1. Drain charge-air coolant (→ Page 113).
2. Fill with charge-air coolant (→ Page 114).

### 7.16.3 Charge-air coolant – Draining

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Sealing ring	(→ Spare Parts Catalog)	

#### WARNING



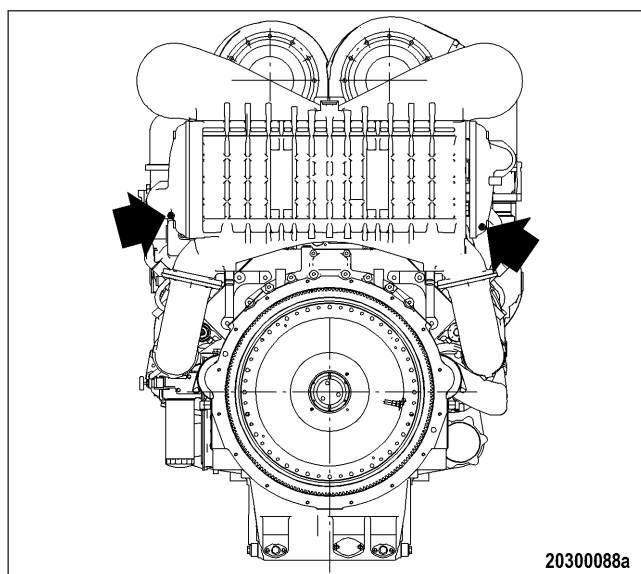
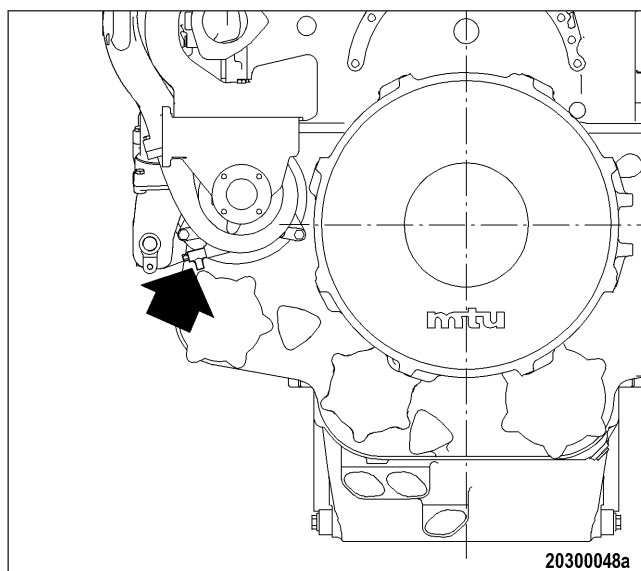
Coolant is hot and under pressure.

#### Risk of injury and scalding!

- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

#### Charge-air coolant – Draining

1. Provide an appropriate container to drain the coolant into.
2. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
3. Continue to turn breather valve counterclockwise and remove.
4. Draw off precipitated corrosion inhibitor oil from the expansion tank through filler neck.
5. Open drain valve or plug screw and drain coolant at the LT coolant pump.
6. Drain residual coolant at intercooler, left and right side.
7. Close all drain valves and install drain plugs with new sealing rings.
8. Close breather valve of filler neck.



## 7.16.4 Charge-air coolant system – Filling

### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ MTU Fluids and Lubricants Specification (A001061/..) is available.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Charge-air coolant		
Sealing ring	(→ Spare Parts Catalog)	

#### WARNING



Engine noise above 85 dB (A).  
**Risk of damage to hearing!**

- Wear ear protectors.

#### CAUTION

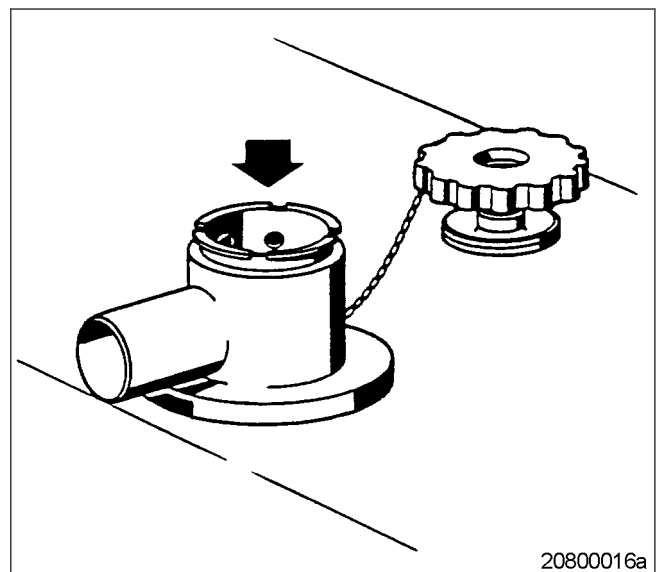


Cold coolant in hot engine can cause thermal stress.  
**Formation of cracks in components!**

- Fill / top up coolant only into cold engine.

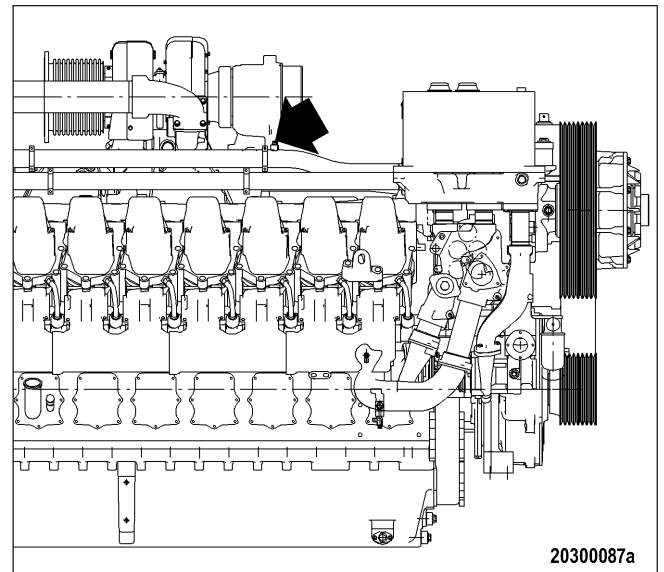
### Preparatory steps

1. Turn breather valve of filler neck on coolant expansion tank counterclockwise to first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Remove plugs from filling points on the coolant lines from and to the intercooler.



## Charge-air coolant system – Filling

1. Pour treated coolant via the filling point on the coolant line from and to the intercooler and via the filler neck of the expansion tank until coolant is visible at the marking plate.
2. Install plugs with new sealing rings at the filling points.
3. Check proper condition of breather valve, clean sealing faces if required.
4. Set breather valve onto filler neck and close it.



## Final steps

1. Start the engine and operate it at idle speed for some minutes.
2. Check coolant level (→ Page 111).

### 7.16.5 Charge-air coolant pump – Checking pressure relief port

#### DANGER



Rotating and moving engine parts.

**Risk of crushing, danger of parts of the body being caught or pulled in.**

- Only run the engine at low power. Keep away from the engine's danger zone.

#### WARNING



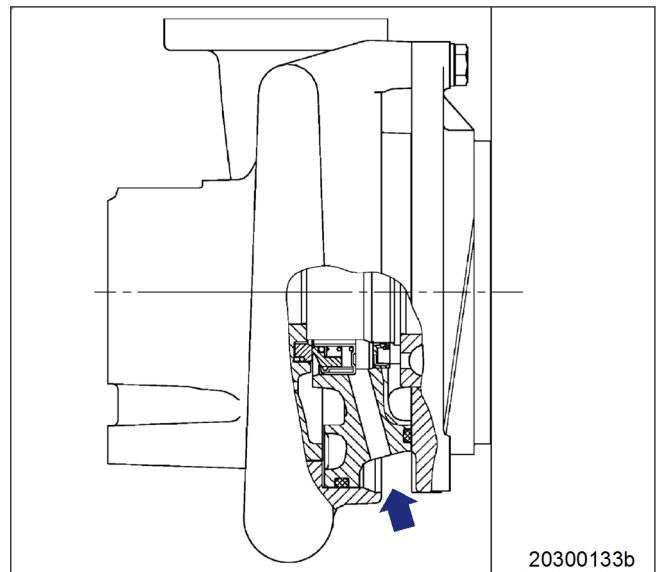
A high level of noise is produced when the engine is running.

**Risk of damage to hearing.**

- Wear ear defenders.

#### Charge-air coolant pump – Checking pressure relief port

1. Check pressure relief port for oil and coolant discharge.
2. Shut down engine (→ Page 34) and secure against being restarted, observe general “Maintenance and Repair” safety instructions.
3. Clean the pressure relief port with a wire if it is dirty.
  - Permissible coolant discharge rate: up to 10 drops per hour.
  - Permissible oil discharge rate: up to 5 drops/hour.
4. If discharge exceeds the specified limits: Contact Service.



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## 7.17 Engine Mounting / Support

### 7.17.1 Engine mounting - Check

#### Engine mounting – Check

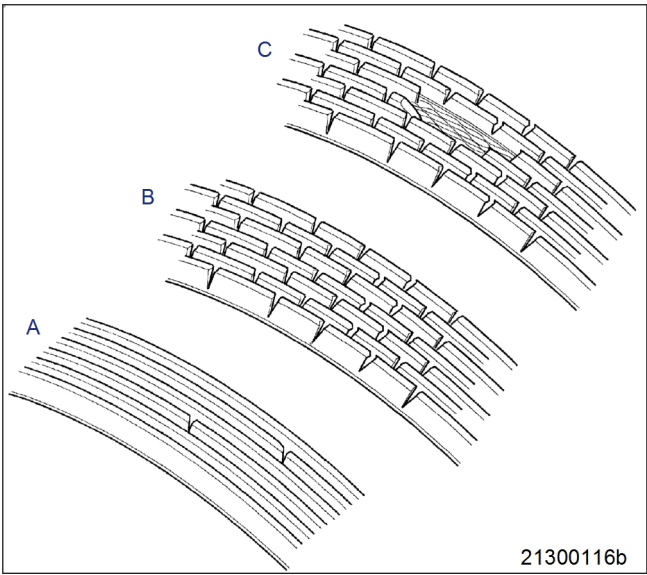
Item	Findings	Action
Visually inspect mounts.	<ul style="list-style-type: none"><li>• Damage</li><li>• Brittleness</li><li>• Deformation</li><li>• Crack formation</li><li>• Swelling visible</li></ul>	Replace (contact Service).

# 7.18 Belt Drive

## 7.18.1 Drive belt - Check condition

### Preconditions

- ☑ Engine is stopped and starting disabled.
- ☑ Protective cover is removed



Item	Findings	Measure
Drive belt A	Singular cracks	None
Drive belt	Belt is oily, shows signs of over-heating	Fit new part (→ Page 124)
Drive belt B	Cracks on entire circumference	
Drive belt C	Material broken out	

## 7.19 Battery-Charging Generator

### 7.19.1 Battery-charging generator - Removal

#### Preconditions

- ☑ Engine is stopped and starting disabled

#### WARNING



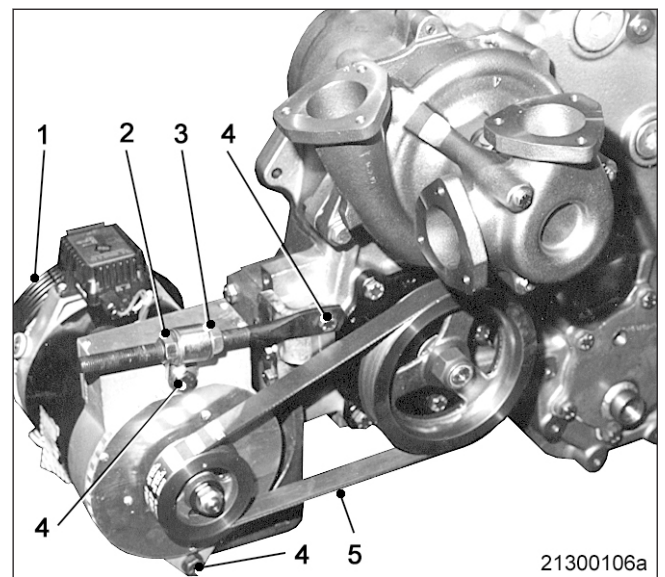
Heavy object.

#### Risk of crushing!

- Use appropriate lifting devices and appliances.

#### Battery-charging generator – Removal

1. Remove guard cover.
2. Label and disconnect electrical cables on battery-charging generator.
3. Protect all cables against damage.
4. Undo nut (3).
5. Tilt battery-charging generator (1) towards engine and remove V-belt (5).
6. Unscrew nut (2) from stud.
7. Unscrew bolts (4) and carefully remove battery-charging generator with bracket and stud
8. Clean battery-charging generator thoroughly (→ Page 120).
9. Assemble in reverse order.
10. Adjust drive belt (→ Page 122).



## 7.19.2 Battery-charging generator – Check

### Preconditions

- ☑ Engine is stopped and starting disabled.

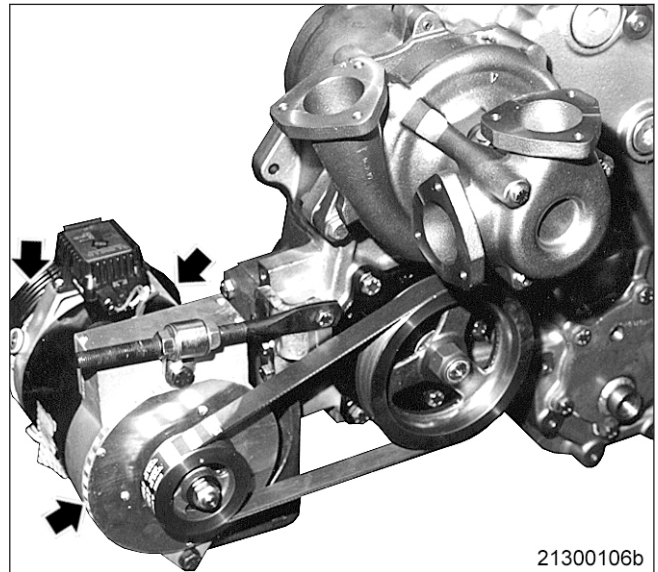
#### WARNING



Compressed air

#### Risk of injury!

- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.



### Battery-charging generator check

Item	Diagnosis	Task
Ventilation area (arrow)	Clean	None
Ventilation area (arrow)	Dirty	Clean

### Battery-charging generator cleaning

Note: Dry-clean battery-charging generator only.

1. Remove thick dirt from battery-charging generator.
2. Blow out ventilation area (arrow) with compressed air until all dust is cleared.

### 7.19.3 Generator – Cleaning

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Cleaner (Snow-White 11-0)	40460	1
Cleaner (Hakupur 312)	30390	1

#### WARNING



Compressed air gun ejects a jet of pressurized air.

**Risk of injury to eyes and damage to hearing, risk of rupturing internal organs.**

- Never direct air jet at people.
- Always wear safety goggles/face mask and ear defenders.

#### WARNING



Cleaner is extremely caustic.

**Risk of injury and suffocation!**

- Avoid contact with eyes and skin.
- Do not inhale vapors and smoke.
- Do not eat, drink, smoke when working with cleaner.
- Wear protective clothing, gloves, and goggles / safety mask.
- Take measures against electrostatic charging.

#### NOTICE



Cleaning agents should not be left to take effect for too long.

**Damage to components is possible.**

- Observe manufacturer's instructions.

#### Clean generator

1. Clean generator with compressed air only; do not use any liquids in cleaning process.
2. Clean all metallic parts with cleaner (Snow-White 11-0), then rinse with cleaner (Hakupur 312).
3. Blow off all components thoroughly with compressed air.

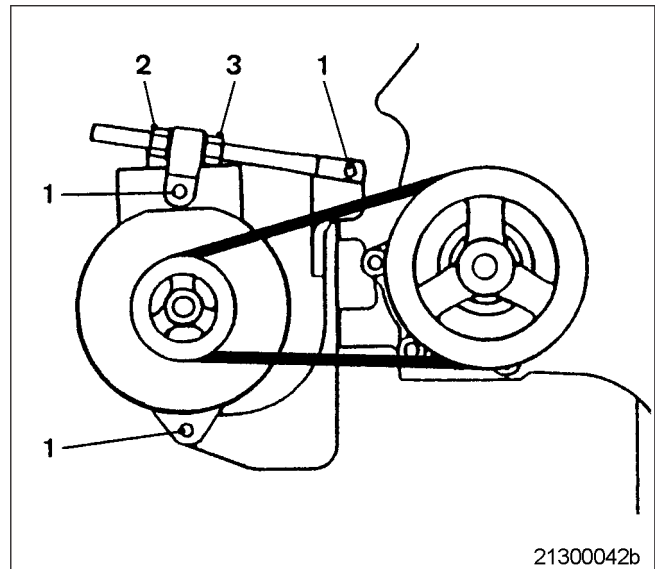
#### 7.19.4 Battery-charging generator drive – Drive belt tension adjustment

##### Preconditions

- ☑ Engine is stopped and starting disabled.

##### Adjusting belt tension

1. Loosen locknut (2) and screws (1).
2. Tension drive belt with tensioning nut (3) and check belt tension (→ Page 123).
3. Tighten locknut (2).
4. Tighten screws (1).
5. Install guard cover.



## 7.19.5 Battery-charging generator drive – Drive belt tension check

### Preconditions

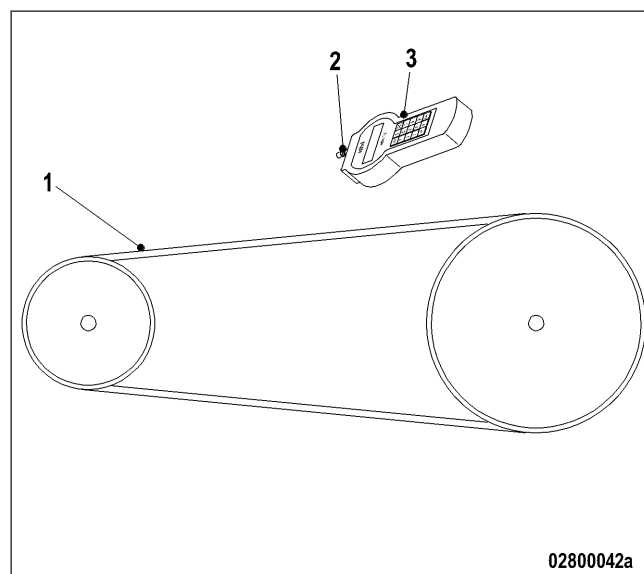
- ☒ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Belt tension tester	Y4345711	1

### Preparatory steps

1. Remove guard cover.
2. Check belt condition visually (→ Page 118).



### Checking drive belt tension

1. Fit measuring head (2) on belt-tension tester (3) and hit drive belt (1) with a suitable tool.
2. Hold belt tension tester over belt drive until the measured value is displayed. For specifications, refer to table below.

Application	Value for new drive belt	Value for used drive belt
Series 4000	92 Hz to 96 Hz	80 Hz to 84 Hz

3. If the measured values deviate from the specifications above, adjust drive belt tension (→ Page 122).

## 7.19.6 Battery-charging generator drive – Drive belt replacement

### Preconditions

- ☑ Engine is stopped and starting disabled.

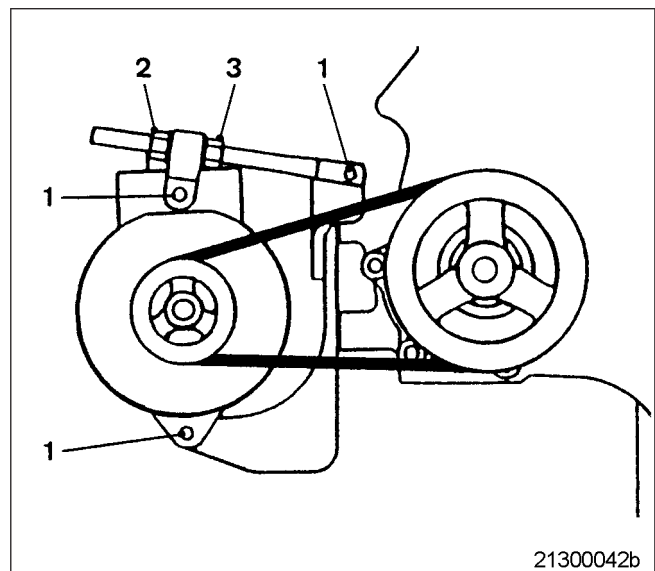
### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Drive belt	(→ Spare Parts Catalog)	

Note: In the event of drive belt failure during engine operation fit a new drive belt as quickly as possible. Non-compliance with these instructions may lead to severe consequential damage to drive unit and gear train, since pretension by the drive belt is no longer provided. Therefore, engine operation without drive-belt connection is not allowed.

### Battery-charging generator drive – Drive belt replacement

1. Remove guard cover.
2. Loosen locknut (2) and screws (1).
3. Release drive belt with tensioning nut (3) and take off belt.
4. Clean belt pulleys.
5. Fit new drive belt.
6. Tension drive belt with tensioning nut (3) and check belt tension (→ Page 122).
7. Tighten locknut (2).
8. Tighten screws (1).
9. Install guard cover.
10. Check belt tension after 30 minutes and again after 8 hours engine runtime.





## 7.20 Fan Drive

### 7.20.1 Fan drive – Drive belt tension check / adjustment

#### Preconditions

- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

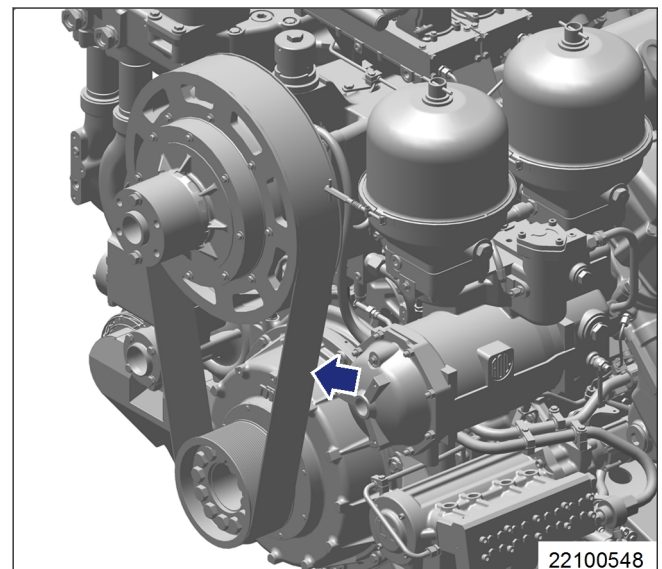
Designation / Use	Part No.	Qty.
Optibell 2 belt tension tester	Y4345711	1

#### Preparatory steps

1. Remove protective cover.
  2. Check belt condition visually (→ Page 118).
- Result: For drive belt replacement (→ Page 127).

#### Checking V-belt tension – Rockford S270 fan clutch

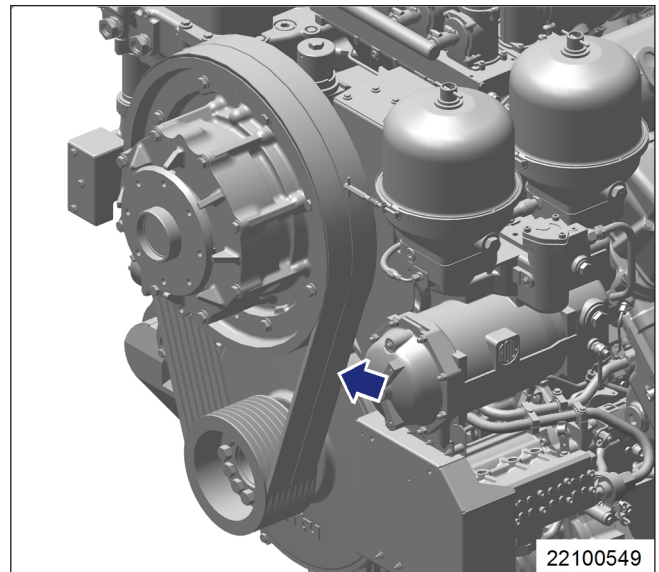
1. Switch on belt tension tester.
2. Hold measuring tip of belt tension tester over belt drive. Tap drive belt (arrow) with a suitable tool.
3. Hold belt tension tester over belt drive until the measured value is indicated.



Initial assembly at MTU	Initial operation with fan	Re-tensioning
None	60 Hz $\pm$ 1 Hz	52 Hz $\pm$ 1 Hz

## Checking V-belt tension – Rockford S370 fan clutch

1. Switch on belt tension tester.
2. Hold measuring tip of belt tension tester over belt drive. Tap drive belt (arrow) with a suitable tool.

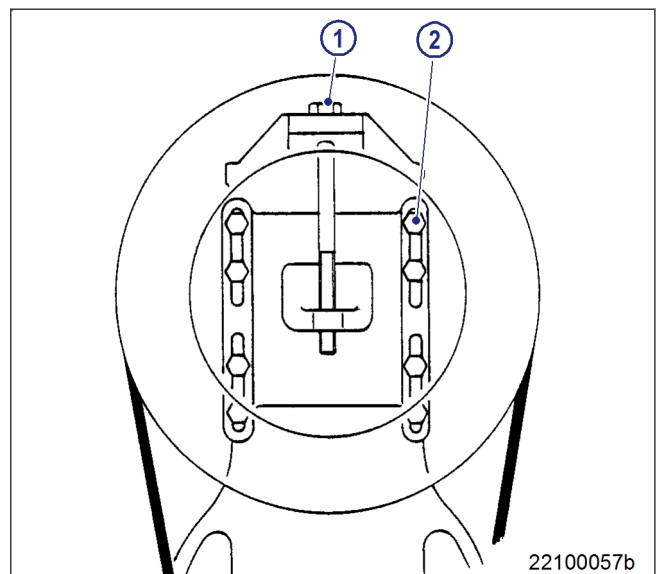


3. Hold belt tension tester over belt drive until the measured value is indicated.

Initial assembly at MTU	Initial operation with fan	Re-tensioning
36 Hz $\pm$ 5 Hz	49 Hz $\pm$ 2 Hz	44 Hz $\pm$ 2 Hz

## Adjusting drive belt tension

1. Release screws (2) until fan clutch can be moved.
2. Tighten stud (1) until the required frequency is achieved.



3. For Rockford S270 fan clutch: Tighten screws (2) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M12x60	Tightening torque		100 Nm + 10 Nm

4. For Rockford S370 fan clutch: Tighten screws (2) to specified tightening torque.

Name	Size	Type	Lubricant	Value/Standard
Screw	M16x80	Tightening torque		270 Nm + 10 Nm

## 7.20.2 Fan drive – Drive belt replacement

### Preconditions

- ☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

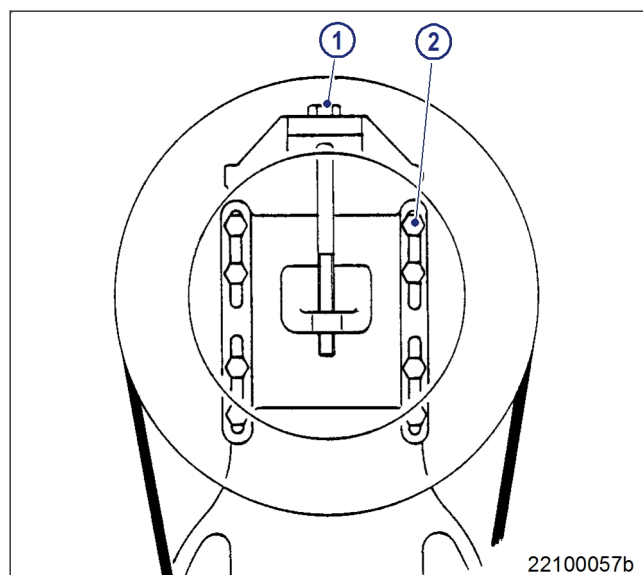
Designation / Use	Part No.	Qty.
Drive belt	(→ Spare Parts Catalog)	

### Preparatory steps

1. Remove protective cover.
2. Remove fan.

### Replacing drive belt

1. Release screws (2).
2. Slacken off stud (1) until drive belt can be removed.
3. Clean belt pulleys.
4. Fit new drive belt on belt pulleys, ensuring that it is not under tension.
5. Adjust belt tension (→ Page 125).



## 7.21 Wiring (General) for Engine/Gearbox/Unit

### 7.21.1 Engine wiring - Check

#### Preconditions

☒ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Isopropyl alcohol	X00058037	1

#### Checking engine wiring

1. Check securing screws of cable clamps on engine and tighten loose threaded connections.
2. Ensure that cables are fixed in their clamps and cannot swing freely.
3. Check that cable clamps are firm, tighten loose cable clamps.
4. Replace faulty cable clamps.
5. Visually inspect the following electrical line components for damage:
  - Connector housing
  - Contacts
  - Sockets
  - Cables and terminals
  - Plug-in contacts

Result: Contact Service if cable conductors are damaged.

Note: Close male connectors that are not plugged in with the protective cap supplied.

6. Clean dirty connector housings, sockets and contacts using isopropyl alcohol.
7. Ensure that all sensor connectors are securely engaged.

## 7.22 Accessories for (Electronic) Engine Governor / Control System

### 7.22.1 Engine governor and connectors - Cleaning

#### Preconditions

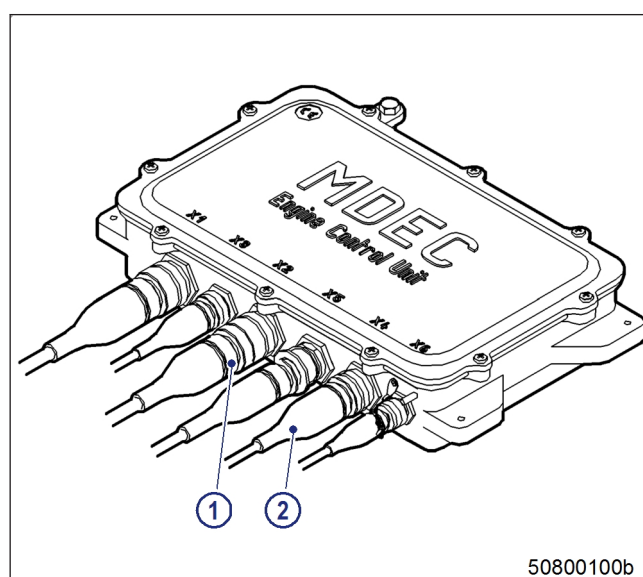
- ☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	F30017884	1
Isopropyl alcohol	X00058037	1

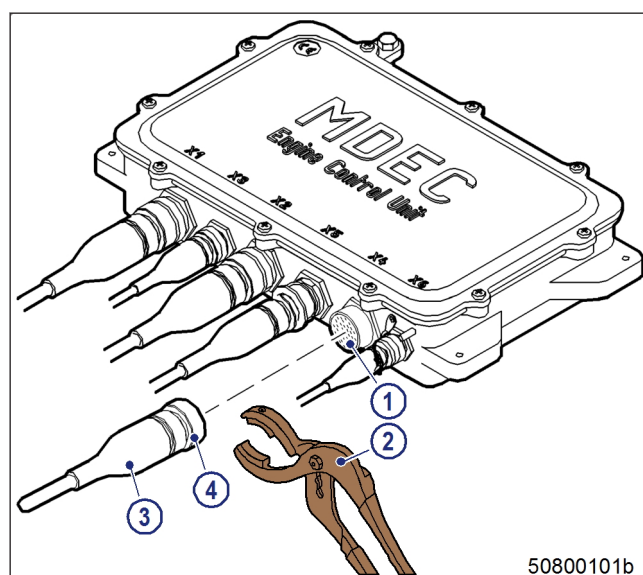
#### Engine governor and connectors - Cleaning

1. Remove coarse dirt from housing surface with isopropyl alcohol.
2. Remove dirt from surface of connectors (1), connector sockets and shrink sleeves (2) using a cloth moistened with isopropyl alcohol.
3. Check legibility of cable labels. Clean or replace illegible labels.



#### Cleaning severely contaminated connectors on engine governor

1. Use connector pliers (2) to disengage bayonet union nut (4) and withdraw connector (3).
2. Clean connector housings, connector socket housings (1) and all contacts with isopropyl alcohol.
3. When connectors, sockets and all contacts are dry: Fit connectors and check governor connections (→ Page 130).



## 7.22.2 Checking engine control unit plug connections

### Preconditions

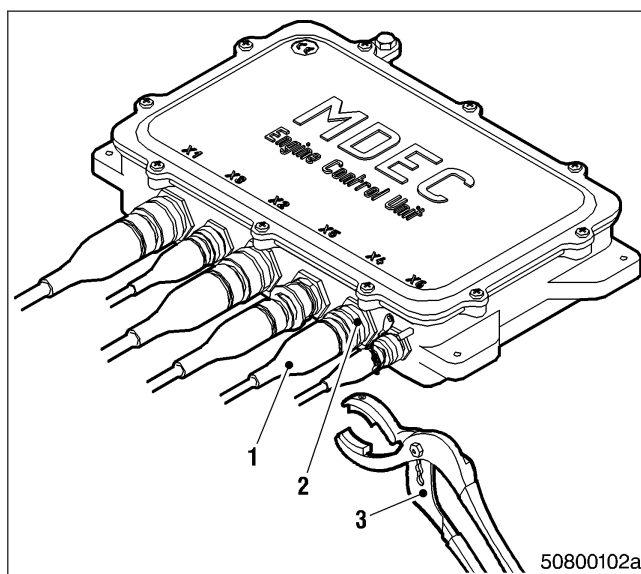
- ☑ Engine shut down and starting disabled.

### Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Connector pliers	0135315483	1

### Checking engine control unit plug connections

1. Use connector pliers (3) to make certain that all plug-in connections on engine control unit are securely seated.
2. Tighten loose bayonet couplings (2) with connector pliers (3) by turning them clockwise until they latch into place.
3. Make sure that unassigned sockets are closed off with cover caps.
4. Contact Service if bayonet union nut is defective.



# 8 Appendix A

## 8.1 Abbreviations

Abbreviation	Meaning	Explanation
A/D	Analog/Digital	Transformer: transforms sensor voltages into numeric values
ADEC	Advanced Diesel Engine Controller	Engine management system
AFRS	Air Filter Restriction Sensor	
AGR	Abgasrückführung	Exhaust gas recirculation
AL	Alarm	
ANSI	American National Standards Institute	Association of American standardization organizations
ATL	Abgasturbolader/Abgasturboaufladung	Exhaust turbocharger/exhaust turbocharging
ATS	Air Temperature Sensor	
BR	Baureihe	Series
BV	Betriebsstoffvorschrift	Fluids and Lubricants Specifications, MTU Publication No. A01061/..
CAN	Controller Area Network	Data bus system, bus standard
CDC	Calibration Drift Compensation	Setting of drift compensation in engine governor with DiaSys
CEL	Stop engine light	1st function: Warning lamp (rectify fault as soon as possible) 2nd function: Read out fault codes
CKT	Circuit	
CLS	Coolant Level Sensor	Monitors coolant level
CM	Current Measurement	Current measured value
CPS	Coolant Pressure Sensor	Monitors coolant pressure
CR	Common Rail	
CTS	Coolant Temperature Sensor	Monitors coolant temperature
DDEC	Detroit Diesel Electronic Controls	Engine control system made by Detroit Diesel
DDL	Diagnostic Data Link	Diagnostic lines
DDR	Diagnostic Data Reader	Diagnostic unit
Dia Sys®	Electronic dialog system	
DIN	Deutsches Institut für Normung e. V.	At the same time identifier of German standards (DIN = “Deutsche Industrie-Norm”)
DL	Default Lost	Alarm: Default CAN bus failure
DOC	Diesel Oxidation Catalyst	Oxidation catalyst upstream of the diesel particulate filter
DPF	Dieselpartikelfilter	Diesel particulate filter
DT	Diagnostic Tool	Diagnostic unit
ECM	Electronic Control Module	Electronic control unit of the DDEC system
ECU	Engine Control Unit	Engine governor

Abbreviation	Meaning	Explanation
EDM	Engine Data Module	Memory module for engine data
EE-PROM	Electrically Erasable Programmable Read Only Memory	Electrically Erasable Programmable Read Only Memory
EFPA	Electronic Foot Pedal Assembly	Electronic Foot Pedal Assembly
EGR	Exhaust Gas Recirculation	Exhaust gas recirculation
EIL	Engine Ident Label	
EMU	Engine Monitoring Unit	Engine monitoring unit
ESCM	Extreme Site Condition Management	Power reduction in the case of extreme site conditions
ETK	Ersatzteilkatalog	Spare Parts Catalog
EUI	Electronic Unit Injector	Electronic Unit Injector
FO	Frequency Output	
FPS	Fuel Pressure Sensor	Monitors fuel pressure
FRS	Fuel Restriction Sensor	
FTS	Fuel Temperature Sensor	Monitors fuel temperature
FWCP	Fire Water Control Panel	Governor cabinet
GND	Ground	
HD (HP)	High pressure	
HI	High	Alarm: Measured value exceeds 1st maximum limit value
HIHI	High High	Alarm: Measured value exceeds 2nd maximum limit value
HT	High Temperature	High temperature
IDM	Interface Data Module	Memory module for interface data
INJ	Injector	
ISO	International Organization for Standardization	International umbrella organization for all national standardization institutes
KGS	Kraftgegenseite	Engine free end in accordance with DIN ISO 1204
KS	Kraftseite	Engine driving end in accordance with DIN ISO 1204
L1	Limit 1	Limit value 1
L2	Limit 2	Limit value 2
LED	Light Emitting Diode	Light emitting diode
LLK	Ladeluftkühlung	Intercooler
LO	Low	Alarm: Measured value lower than 1st minimum limit value
LOLO	Low Low	Alarm: Measured value lower than 2nd minimum limit value
LSG	Maximum-speed governor	
LSU	Lambda Sonde Universal	Universal lambda probe
LT	Low Temperature	Low temperature
MCR	Maximum Continuous Rating	Torque limiting curve
N/A	Not Applicable	
ND	Niederdruck	Low pressure



Abbreviation	Meaning	Explanation
NN	Normal Null	Reference surface for height above sea level
NT	Niedertemperatur	
OEM	Original Equipment Manufacturer	
OI	Optimized Idle	
OLS	Oil Level Sensor	Monitors oil level
OPS	Oil pressure sensor	Monitors oil pressure
OTS	Oil Temperature Sensor	Monitors oil temperature
OT	Oberer Totpunkt	Top Dead Center
PAN	Panel	Control panel
PIM	Peripheral Interface Module	Peripheral interface module
PWM	Pulse Width Modulation	Modulated signal
P-xyz	Pressure-xyz	Pressure measuring point, xyz specifies the measuring point designation
RL	Redundancy Lost	Alarm: Redundant CAN bus failure
SAE	Society of Automotive Engineers	U.S. standardization organization
SD	Sensor Defect	Alarm: Sensor failure
SEL	Stop EngineLight	1st function: Warning lamp (stop engine and rectify fault) 2nd function: Read out fault codes
SID	System Identification	
SRS	Synchronous Reference Sensor	OT cylinder 1
SS	Safety System / Security Shutdown	Safety system alarm
TBS	Turbocharger Boost Sensor	Monitors charge-air pressure
TCI	Turbo Compressor Inlet	
TCO	Turbo Compressor Outlet	
TD	Transmitter Deviation	Alarm: Deviation in transmitter values
TPS	Throttle Position Sensor	
TRS	Timing Reference Sensor	
T-xyz	Temperature-xyz	Temperature measuring point, xyz specifies the measuring point designation
U_PDU	Voltage Power Driver Unit	Solenoid valve output stage supply voltage
UDV	Überdruckventil	Pressure relief valve
UT	Unterer Totpunkt	Bottom Dead Center
VNT	Variable Nozzle Turbine	
VSG	Variable-Speed Governor	
VSS	Vehicle Speed Sensor	
WZK	Werkzeugkatalog	Tool Catalog
ZKP	Zuordnung - Kategorie - Parameter	A number assigned to a parameter describing function and allocation

## 8.2 MTU contact persons/service partners

Our worldwide sales network with its subsidiaries, sales offices, representatives and customer service centers ensures fast and direct support on site and the high availability of our products.

### **Local support**

Experienced and qualified specialists place their knowledge and expertise at your disposal.

For locally available support, go to the MTU Internet site: <http://www.mtu-online.com>

### **24h hotline**

With our 24h hotline and the outstanding flexibility of our service staff, we are always ready to assist you – either during operation, for preventive maintenance, corrective work in case of malfunction or changed operating conditions, or for spare parts supply.

Your contact at Headquarters: [Service-support@mtu-online.com](mailto:Service-support@mtu-online.com)

### **Spare parts service**

Fast, simple and correct identification of spare parts for your drive system or vehicle fleet. The right spare part at the right time at the right place.

With this aim in mind, we can call on a globally networked spares logistics system, a central warehouse at headquarters and on-site stores at our subsidiary companies, agencies and service workshops.

Your contact at Headquarters:

E-mail: [spare.parts@mtu-online.com](mailto:spare.parts@mtu-online.com)

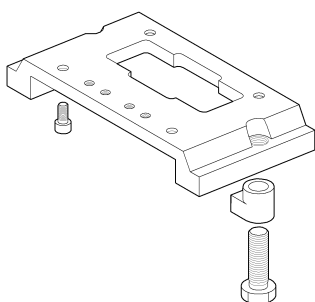
Phone: +49 7541 908555

Fax: +49 7541 908121

## 9 Appendix B

### 9.1 Special Tools

#### Adapter

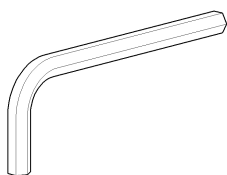


Part No.: F6558528

Qty.: 1

Used in: 7.1.1 Engine – Barring manually (→ Page 52)

#### Allen key



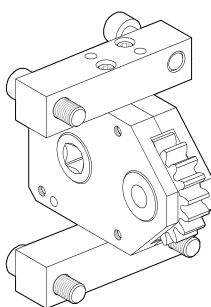
Part No.: F30002817

Qty.: 1

Used in: 7.5.2 Valve clearance – Check and adjustment (→ Page 69)

F30002817b

#### Barring gear

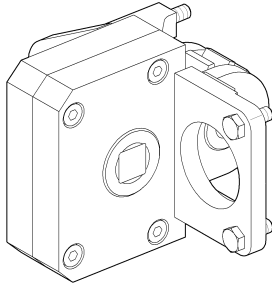


Part No.: F6555766

Qty.: 1

Used in: 7.1.1 Engine – Barring manually (→ Page 52)

### Barring gear

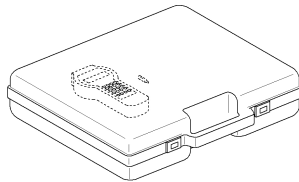


Part No.: F6783293

Qty.: 1

Used in: 7.1.1 Engine – Barring manually (→ Page 52)

### Belt tension tester

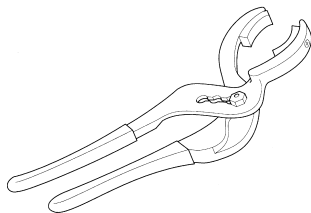


Part No.: Y4345711

Qty.: 1

Used in: 7.19.5 Battery-charging generator drive – Drive belt tension check (→ Page 123)

### Connector pliers



Part No.: 0135315483

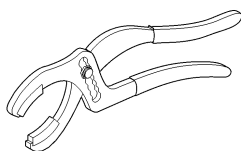
Qty.: 1

Used in: 7.1.2 Engine – Barring with starting system (→ Page 54)

Qty.: 1

Used in: 7.22.2 Checking engine control unit plug connections (→ Page 130)

### Connector pliers

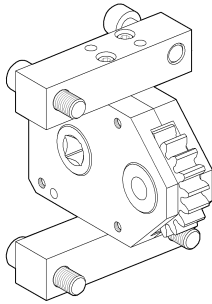


Part No.: F30017884

Qty.: 1

Used in: 7.22.1 Engine governor and connectors – Cleaning (→ Page 129)

### Cranking tool

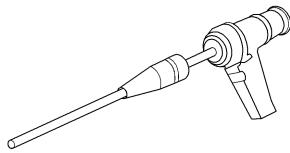


Part No.: F6555766

Qty.: 1

Used in: 7.2.1 Endoscopically examining cylinder liner  
(→ Page 55)

### Endoscope

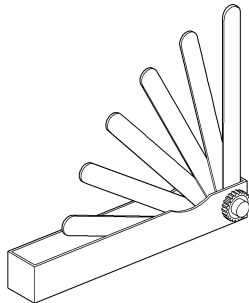


Part No.: Y20097353

Qty.: 1

Used in: 7.2.1 Endoscopically examining cylinder liner  
(→ Page 55)

### Feeler gauge

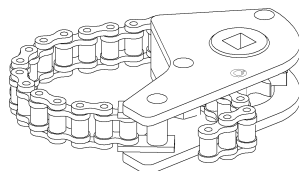


Part No.: Y20010128

Qty.: 1

Used in: 7.5.2 Valve clearance – Check and adjustment  
(→ Page 69)

### Filter wrench



Part No.: F30379104

Qty.: 1

Used in: 7.9.1 Fuel filter – Replacement (→ Page 84)

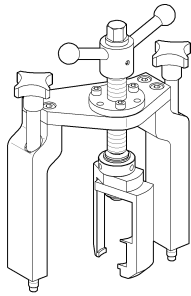
Qty.: 1

Used in: 7.9.4 Auxiliary fuel filter – Replacement (→ Page 87)

Qty.: 1

Used in: 7.15.7 Engine coolant filter – Replacement  
(→ Page 110)

### Installation and removal tool for injector

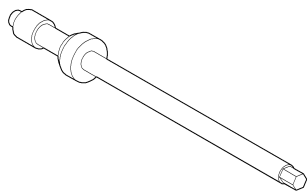


Part No.: F6790161

Qty.: 1

Used in: 7.7.2 Injector – Removal and installation (→ Page 78)

### Milling cutter

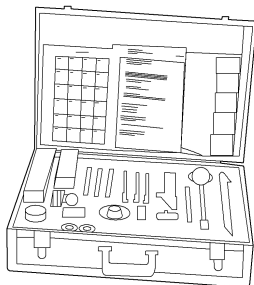


Part No.: F30452739

Qty.: 1

Used in: 7.7.2 Injector – Removal and installation (→ Page 78)

### MTU test kit

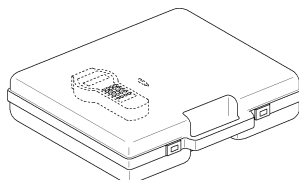


Part No.: 5605892099/00

Qty.: 1

Used in: 7.15.6 Engine coolant – Sample extraction and analysis (→ Page 109)

### Optibell 2 belt tension tester

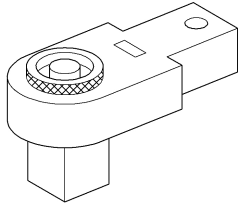


Part No.: Y4345711

Qty.: 1

Used in: 7.20.1 Fan drive – Drive belt tension check / adjustment (→ Page 125)

### Ratchet

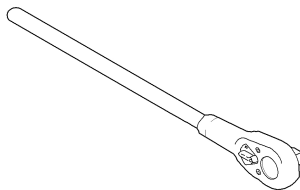


Part No.: F30027340

Qty.: 1

Used in: 7.3.1 Crankcase breather – Oil separator element replacement, diaphragm check and replacement (→ Page 59)

### Ratchet with extension



Part No.: F30006212

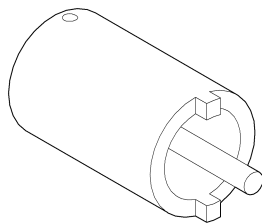
Qty.: 1

Used in: 7.1.1 Engine – Barring manually (→ Page 52)

Qty.: 1

Used in: 7.2.1 Endoscopically examining cylinder liner (→ Page 55)

### Slotted screwdriver

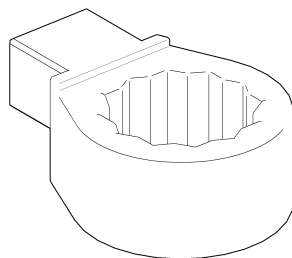


Part No.: F30452578

Qty.: 1

Used in: 7.7.2 Injector – Removal and installation (→ Page 78)

### Socket wrench

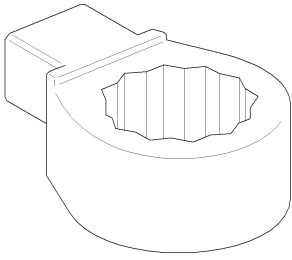


Part No.: F30039526

Qty.: 1

Used in: 7.5.2 Valve clearance – Check and adjustment (→ Page 69)

### Socket wrench



Part No.: F30039518

Qty.: 1

Used in: 7.5.2 Valve clearance – Check and adjustment  
(→ Page 69)

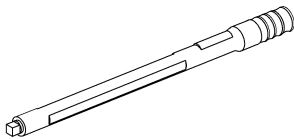
### Steam jet cleaner

Part No.: -

Qty.: 1

Used in: 4.7 Cleaning the plant (→ Page 36)

### Torque wrench 10-60 Nm

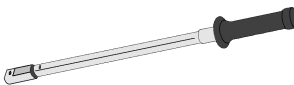


Part No.: F30510423

Qty.: 1

Used in: 7.5.2 Valve clearance – Check and adjustment  
(→ Page 69)

### Torque wrench 60-320 Nm



Part No.: F30047446

Qty.: 1

Used in: 7.5.2 Valve clearance – Check and adjustment  
(→ Page 69)

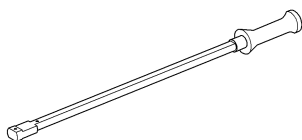


#### Torque wrench, 10-60Nm

Part No.: F30452769

Qty.: 1

Used in: 7.3.4 Crankcase breather – Filter element replacement  
(→ Page 63)

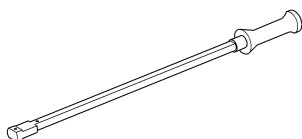


#### Torque wrench, 10-60 Nm

Part No.: F30452769

Qty.: 1

Used in: 7.7.2 Injector – Removal and installation (→ Page 78)

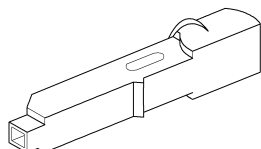


#### Torque wrench, 4-20 Nm

Part No.: F30044239

Qty.: 1

Used in: 7.7.2 Injector – Removal and installation (→ Page 78)

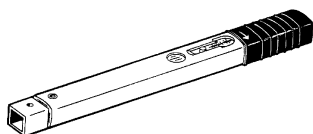


#### Torque wrench, 6 to 50 Nm

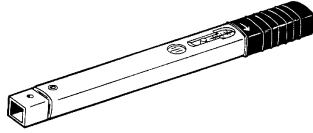
Part No.: F30027336

Qty.: 1

Used in: 7.14.3 Cleaning centrifugal oil filter and replacing filter  
sleeve (→ Page 101)



#### Torque wrench, 6-50 Nm

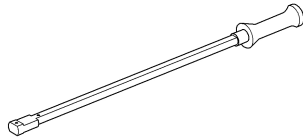


Part No.: F30027336

Qty.: 1

Used in: 7.3.1 Crankcase breather – Oil separator element replacement, diaphragm check and replacement (→ Page 59)

#### Torque wrench, 60-320 Nm



Part No.: F30452768

Qty.: 1

Used in: 7.7.2 Injector – Removal and installation (→ Page 78)

## 9.2 Index

### Numerics

20V 4000 C22 engine data 24

### A

Abbreviations 131

After shutting down the engine 35

Air filter

- Replacement 90

Air filter element

- Cleaning 89

- Removal and installation 91

Automatic oil filter

- Oil filter candles replacement 96

Auxiliary fuel filter

- Replacement 87

### B

Battery-charging generator - Check 120

Battery-charging generator - Removal 119

### C

Centrifugal oil filter

- Cleaning 101

Charge-air coolant

- Change 112

- Level check 111

Charge-air coolant level

- Check 111

Charge-air coolant pump

- Checking pressure relief port 116

Charge-air coolant system - Filling 114

Charge-air coolant - Draining 113

Connectors

- Cleaning 129

Contact persons 134

Coolant

- Change 104, 112

- Sample extraction and analysis 109

Coolant filter

- Replacement 110

Coolant - charge air

- Level check 111

Crankcase breather

- Filter element replacement 63

- Cleaning 61

- Diaphragm check 59

- Oil separator element replacement 59

Crankcase breather (open-circuit crankcase ventilation

- Filter element cleaning 62

Crankshaft transport locking device - For transport with  
flanged-on generator 8

Cylinder

- Designation 17

Cylinder head cover

- Removal and installation 74

Cylinder liner

- Endoscopic examination 55

### D

Designations

- Engine sides and cylinders 17

Drive belt - Check condition 118

Dust bowl

- Cleaning 89

### E

ECU 4 alarms 41

Edge-type fuel filter - Draining 86

Engine

- Barring manually 52

- Starting in manual mode 32

- Stopping in manual mode 34

- Wiring check 128

Engine coolant

- Change 104

- Draining 105

- Filling 106

- Level check 103

- Sample extraction and analysis 109

Engine coolant filter

- Replacement 110

Engine coolant pump

- Checking pressure relief port 108

Engine governor

- Cleaning 129

Engine layout 18

Engine mounting

- Check 117

Engine oil

- Centrifugal oil filter

- Cleaning 101

- Filter sleeve

- Replacing 101

Engine oil level

- Checking 94

Engine oil - Change 95

Engine sides

- Designation 17

Engine wiring

- Check 128

### F

Fan drive

- Drive belt replacement 127

- Drive belt tension check / adjustment 125

Filter replacement

- Fuel 87

Filter sleeve

- Replacing 101

Firing order 28

- Fuel filter
  - Replacing 84
- Fuel prefilter
  - Draining 85
- Fuel system
  - Venting 83

## G

- Generator
  - Cleaning 121
- Grounding device
  - Carbon brush check 65
- Grounding device
  - Carbon brush replacement 67

## H

- Hotline 134
- HP pump
  - Filling with engine oil 75
  - Relief bore check 76

## I

- Injector
  - Installation 78
  - Removal 78
  - Replacement 77
- Instructions and comments on endoscopic and visual examination of cylinder liners 57
- Intercooler
  - Check water drain for coolant leakage and absence of restrictions 88

## M

- Main engine dimensions 29
- Maintenance Schedule
  - Maintenance Schedule task reference table [QL1] 37
- MTU contact persons 134

## O

- Oil indicator filter
  - Check 99
  - Cleaning 99
- Operational checks 33

## P

- Putting into operation
  - Preparation after extended out-of-service periods (>3 months) 30
- Putting the engine into operation
  - Preparation after scheduled out-of-service-period 31

## S

- Safety notices, standards 16
- Safety regulation
  - Environmental protection 14

- Safety regulations
  - Consumables 14
  - Fire prevention 14
  - Fluids and lubricants 14
  - Important provisions 5
  - Maintenance work 11
  - Operation 10
  - Organizational requirements 6
  - Personnel requirements 6
  - Repair work 11
  - Safety notices, standards 16
  - Startup 10
- Sensors and actuators - Overview 21
- Service indicator
  - Signal ring position check 92
- Service partners 134
- Spare parts service 134
- Starter
  - Condition check 93
- System
  - Cleaning 36

## T

- Transport 7
- Troubleshooting 38

## V

- Valve clearance - Check and adjustment 69
- Valve gear
  - Lubrication 68